SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

DEPARTMENT OF MECHANICAL ENGINEERING

Program

Mechanical Engineering

2024

Scheme & Syllabus

Effective from the Academic Year 2024 - 2025

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2024

OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

III SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours/ Week				Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	PCC/BSC	BMA301TM	NUMERICAL METHODS AND TRANSFORM TECHNIQUES	BSC	BSC	03	00	00	03	03	50	50	100	03
2	IPCC	BME302G	BASIC THERMODYNAMICS	ME	ME	03	00	02	03	03	50	50	100	04
3	IPCC	BME303G	MATERIAL SCIENCE AND METALLURGY	ME	ME	03	00	02	03	03	50	50	100	04
4	PCC	BME304T	MECHANICS OF MATERIALS	ME	ME	03	00	00	03	03	50	50	100	03
5	PCCL	BME305L	MEASUREMENT AND METROLOGY LAB	ME	ME	00	00	02	00	03	50	50	100	01
6	ESC/ ETC/PLC	BME306Wx	ESC/ETC/PLC	ME	ME	03	00	00	03	03	50	50	100	03
7	UHV	BHU307TK	UHV-1: SOCIAL CONNECT AND RESPONSIBILITIES	ME	ME	01	00	00	00	01	50	50	100	01
8	AEC/SEC	BME308Ax	ABILITY ENHANCEMENT COURSE III / SKILL ENHANCEMENT COURSE III	ME	ME	00 01	00 00	02 00	00 00	03	50	50	100	01
9	MC	BNS309NK	NATIONAL SERVICE SCHEME (NSS)	NSS / PED / Yoga/ Music		00	00	02	00	00	--	--	--	00
		BPE309NK	PHYSICAL EDUCATION (PE) (SPORTS AND ATHLETICS)											
		BYO309NK	YOGA											
		BMU309NK	MUSIC											
									TOTAL		**400**	**400**	**800**	**20**

ESC/ETC/PLC			
BME306W1	MANUFACTURING TECHNOLOGY	BME306W3	MECHANICAL MEASUREMENTS AND METROLOGY
BME306W2	MECHATRONICS	BME306W4	WASTE HANDLING AND MANAGEMENT
ABILITY ENHANCEMENT COURSE I / SKILL ENHANCEMENT COURSE - I			
BME308A1	GENERATIVE DESIGN LAB	BME308A3	FOUNDRY TECHNOLOGY LAB
BME308A2	FUEL CONVERSION LAB	BME308A4	DATA WRANGLING, ANALYSIS AND VISUALIZATION

COURSE PRESCRIBED TO LATERAL ENTRY DIPLOMA HOLDERS ADMITTED TO III SEMESTER OF THE B.E. PROGRAMS

1	BSC	BMA310NK	ADDITIONAL MATHEMATICS I	BSC	BSC	03	00	00	01	03	50	50	100	0

Note: BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses. **UHV:** Universal Human Value Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **MC:** Mandatory Course

L – Lecture, **T –** Tutorial, **P-** Practical/ Drawing, **S –** Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB**: Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga/ Music: All the students have to register for any one of the courses namely NSS/ PE/ Yoga/Music with the concerned coordinator of the course during the first week of the III semester. Activities shall be carried out between the III semester and VI semester (4 Semesters). The events shall be appropriately scheduled and the same shall be reflected in the Institute Academic and Activity Calendar. The course will be evaluated only for the CIA marks and will not have SEE component. The students who successfully complete the registered course will be awarded with "**PP**" grade and the students not completing the same will be awarded with "**NP**" grade. The marks and the grade obtained by the student will be included in the SIXTH semester grade card. The course will not be considered for the SGPA and CGPA calculations and Vertical Progression, however, completion of the course is mandatory for the award of the Degree.

Non–Credit Mandatory Courses (NCMC):

A. Additional Mathematics I:

1) This course is prescribed in the III semester to the lateral entry Diploma holders admitted to the second year of the B.E., programs.
2) They shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Assessment (CIA).
3) This course is slated for both CIA and SEE.
4) This course shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.
5) Successful completion of the course shall be indicated with Pass (PP) grade in the grade card. Non-completion of the courses will lead to the award of Not Pass (NP) Grade.
6) In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIA marks, 35% of the prescribed SEE marks and a overall of 40% of Total Marks, shall be deemed to have secured an NP grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.

B. National Service Scheme (NSS) / Physical Education (Sport and Athletics) (PED) / Yoga/ Music:

1) Securing 50% or more in CIA leads to successful completion of the registered course.

2) In case, any student fails to register for NSS, PE, Yoga or Music/ fails to secure the minimum requirements as mentioned in (B).1, they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
3) Securing 50% or more in CIA leads to successful completion of the registered course.
4) In case, any student fails to register for NSS, PE, Yoga or Music /fails to secure the minimum requirements as mentioned in B.1), they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
5) Successful completion of the course shall be indicated with a PP Grade in the grade card.
6) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2024

OUTCOME BASED EDUCATION(OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

IV SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours/ Week				Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	IPCC	BME401G	APPLIED THERMODYNAMICS	ME	ME	03	00	02	03	03	50	50	100	04
2	IPCC	BME402G	MACHINING SCIENCE AND JIGS & FIXTURES	ME	ME	03	00	02	03	03	50	50	100	04
3	PCC	BME403T	KINEMATICS OF MACHINES	ME	ME	03	00	00	03	03	50	50	100	03
4	PCC	BME404T	FLUID MECHANICS	ME	ME	03	00	00	03	03	50	50	100	03
5	PCCL	BME405L	MACHINE DRAWING AND GD & T	ME	ME	00	00	02	00	03	50	50	100	01
6	ESC/ ETC/PLC	BME406Wx	ESC/ETC/PLC	BSC	BSC	03	00	00	03	03	50	50	100	03
7	UHV	BHU407TK	UHV-2: UNDERSTANDING HARMONY AND ETHICAL CONDUCT	ME	ME	01	00	00	00	01	50	50	100	01
8	AEC	BME408Ax	ABILITY ENHANCEMENT COURSE IV / SKILL ENHANCEMENT COURSE IV	ME	ME	00 01	00 00	02 00	00 00	03	50	50	100	01
9	BSC	BBS409TZ	BIOLOGY FOR ENGINEERS	BSC	BSC	02	00	00	02	03	50	50	100	02
10	MC	BNS410NK	NATIONAL SERVICE SCHEME (NSS)	NSS / PED / Yoga/ Music		00	00	02	00	00	--	--	--	00
		BPE410NK	PHYSICAL EDUCATION (PE) (SPORTS AND ATHLETICS)											
		BYO410NK	YOGA											
		BMU410NK	MUSIC											
									TOTAL	**450**	**450**	**900**	**22**	

ESC/ETC/PLC			
BME406W1	ENGINEERING STATISTICS & COMPLEX ANALYSIS	BME406W3	ADDITIVE MANUFACTURING
BME406W2	METAL JOINING PROCESSES	BME406W4	MICRO ELECTRO MECHANICAL SYSTEMS
ABILITY ENHANCEMENT COURSE IV / SKILL ENHANCEMENT COURSE - II			
BME408A1	PROTOTYPE FABRICATION LAB	BME408A3	ROBOT PROGRAMMING LAB
BME408A2	FUEL TESTING LAB	BME408A4	MACHINE LEARNING LAB

COURSE PRESCRIBED TO LATERAL ENTRY DIPLOMA HOLDERS ADMITTED TO III SEMESTER B.E. PROGRAMS

1	BSC	BMA411NK	ADDITIONAL MATHEMATICS II	BSC	BSC	02	00	00	01	03	50	50	100	00

Note: BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses. **UHV:** Universal Human Value Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **MC:** Mandatory Course

L – Lecture, **T –** Tutorial, P- Practical/ Drawing, **S –** Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB**: Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga/ Music: All the students have to register for any one of the courses namely NSS/ PE/ Yoga with the concerned coordinator of the course during the first week of the III semester. Activities shall be carried out between the III semester and VI semester (4 Semesters). The events shall be appropriately scheduled and the same shall be reflected in the Institute Academic and Activity Calendar. The course will be evaluated only for the CIA marks and will not have SEE component. The students who successfully complete the registered course will be awarded with "PP" grade and the students not completing the same will be awarded with "NP" grade. The marks and the grade obtained by the student will be included in the SIXTH semester grade card. The course will not be considered for the SGPA and CGPA calculations and Vertical Progression, however, completion of the course is mandatory for the award of the Degree.

Non–Credit Mandatory Courses (NCMC):

A. Additional Mathematics II:

1) This course is prescribed in the IV semester to the lateral entry Diploma holders admitted to the second year of the B.E., programs.
2) They shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Assessment (CIA).
3) This course is slated for both CIA and SEE.
4) The course shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.
5) Successful completion of the course shall be indicated with Pass (PP) grade in the grade card. Non-completion of the courses will lead to the award of Not Pass (NP) Grade.
6) In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIA marks, 35% of the prescribed SEE marks and a overall of 40% of Total Marks, shall be deemed to have secured an NP grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s

B. National Service Scheme (NSS) / Physical Education (Sport and Athletics) (PED) / Yoga:

1) Securing 50% or more in CIA leads to successful completion of the registered course.

2) In case, any student fails to register for NSS, PE, Yoga or Music/ fails to secure the minimum requirements as mentioned in B.1), they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
3) Securing 50% or more in CIA leads to successful completion of the registered course.
4) In case, any student fails to register for NSS, PE, Yoga or Music /fails to secure the minimum requirements as mentioned in B.1), they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
5) Successful completion of the course shall be indicated with a PP Grade in the grade card.
6) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2024

OUTCOME BASED EDUCATION(OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

V SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours/ Week				Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	IPCC	BME501G	FINITE ELEMENT METHOD	ME	ME	03	00	02	03	03	50	50	100	04
2	IPCC	BME502G	DYNAMICS OF MACHINES	ME	ME	03	00	02	03	03	50	50	100	04
3	PCC	BME503T	TURBOMACHINES	ME	ME	03	00	00	03	03	50	50	100	03
4	PCC	BME504T	NON-TRADITIONAL MACHINING	ME	ME	03	00	00	03	03	50	50	100	03
5	PCCL	BME505L	FLUID MECHANICS AND MACHINERY LAB	ME	ME	00	00	02	00	03	50	50	100	01
6	PEC	BME506Ex	PROFESSIONAL ELECTIVE I	ME	ME	03	00	00	03	03	50	50	100	03
7	PROJ	BME507P	MINI-PROJECT WORK	ME	ME	00	00	02	02	03	50	--	50	02
8	AEC	BBS508AK	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	ME	ME	01	00	00	00	02	50	50	100	01
9	BSC	BBS509TK	ENVIRONMENTAL STUDIES	BSC	BSC	01	00	00	00	01	50	50	100	01
10	MC	BNS510NK	NATIONAL SERVICE SCHEME (NSS)	NSS / PED / Yoga/ Music		00	00	02	00	00	--	--	--	00
		BPE510NK	PHYSICAL EDUCATION (PE) (SPORTS AND ATHLETICS)											
		BYO510NK	YOGA											
		BMU510NK	MUSIC											
									TOTAL		**450**	**400**	**850**	**22**

PROFESSIONAL ELECTIVE COURSE I			
BME506E1	SMART MATERIALS	BME506E3	FUTURE MOBILITY SYSTEMS
BME506E2	INDUSTRIAL ROBOTICS	BME506E4	OPERATIONS RESEARCH

Note: HSMC: Humanities Science & Management Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses, **PEC:** Professional Elective Course, **MC:** Mandatory Course, **PROJ:** Project Work

L – Lecture, **T –** Tutorial, P- Practical/ Drawing, **S –** Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB**: Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga/ Music: All the students have to register for any one of the courses namely NSS/ PE/ Yoga/ Music with the concerned coordinator of the course during the first week of the III semester. Activities shall be carried out between the III semester and VI semester (4 Semesters). The events shall be appropriately scheduled and the same shall be reflected in the Institute Academic and Activity Calendar. The course will be evaluated only for the CIA marks and will not have SEE component. The students who successfully complete the registered course will be awarded with "PP" grade and the students not completing the same will be awarded with "NP" grade. The marks and the grade obtained by the student will be included in the SIXTH semester grade card. The course will not be considered for the SGPA and CGPA calculations and Vertical Progression, however, completion of the course is mandatory for the award of the Degree.

Professional Elective Course (PEC): A Professional Elective Course (PEC) is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses are added to supplement the learning with the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Mini Project (PROJ): Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

Non–Credit Mandatory Courses (NCMC):

National Service Scheme (NSS)/Physical Education (Sport and Athletics) (PED)/ Yoga/ Music:

1) Securing 50% or more in CIA leads to successful completion of the registered course.
2) In case, any student fails to register for NSS, PE, Yoga or Music/ fails to secure the minimum requirements as mentioned in Sl. No. 1) above, they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
3) Securing 50% or more in CIA leads to successful completion of the registered course.
4) In case, any student fails to register for NSS, PE, Yoga or Music /fails to secure the minimum requirements as mentioned in B.1), they shall be awarded with NP Grade. In such a case, the student has to fulfill the course requirements during subsequent semester/s.
5) Successful completion of the course shall be indicated with a PP Grade in the grade card.
6) These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree.

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2024

OUTCOME BASED EDUCATION(OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

VI SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours/ Week				Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	HSMC/ PCC	BME601T	TECHNOLOGY ENTREPRENEURSHIP AND BUSINESS ECONOMICS	ME	ME	03	00	00	03	03	50	50	100	03
2	IPCC	BME602G	HEAT TRANSFER	ME	ME	03	00	02	03	03	50	50	100	04
3	PCC	BME603T	DESIGN OF MACHINE ELEMENTS – I	ME	ME	03	00	00	03	03	50	50	100	03
4	PEC	BME604Ex	PROFESSIONAL ELECTIVE COURSE-II	ME	ME	03	00	00	03	03	50	50	100	03
5	OEC	BME605Qx	OPEN ELECTIVE COURSE-I	ME	ME	03	00	00	03	03	50	50	100	03
6	PROJ	BME606P	PROJECT WORK PHASE I	ME	ME	00	00	02	02	03	50	50	100	02
7	PCCL	BME607L	ADDITIVE MANUFACTURING LAB	ME	ME	00	00	02	00	03	50	50	100	01
8	AEC	BME608Ax	ABILITY ENHANCEMENT COURSE - III/ SKILL ENHANCEMENT COURSE - III	ME	ME	00 01	00 00	02 00	00 00	03	50	50	100	01
9	NCMC	BNSK609NK	NATIONAL SERVICE SCHEME (NSS)	NSS / PED / Yoga/ Music		00	00	02	00	00	--	--	--	00
		BPEK609NK	PHYSICAL EDUCATION (PE) (SPORTS AND ATHLETICS)											
		BYOK609NK	YOGA											
		BMUK609NK	MUSIC											
										TOTAL	**400**	**400**	**800**	**20**

PROFESSIONAL ELECTIVE COURSE - II			
BME604E1	HYDRAULICS AND PNEUMATICS	BME604E3	REFRIGERATION AND AIR-CONDITIONING
BME604E2	INDUSTRIAL AUTOMATION AND CONTROL	BME604E4	TECHNOLOGIES FOR CLEAN ENERGY
OPEN ELECTIVE COURSE - I			
BME605Q1	NON-CONVENTIONAL ENERGY SOURCES	BME605Q3	INTRODUCTION TO AUTOMOBILE ENGINEERING
BME605Q2	HYBRID AND ELECTRIC VEHICLES	BME605Q4	INTRODUCTION TO COMPUTER INTEGRATED MANUFACTURING
ABILITY ENHANCEMENT COURSE III / SKILL ENHANCEMENT COURSE - III			
BME608A1	DESIGN OF EXPERIMENTS LAB	BME608A3	METAL JOINING AND TESTING LAB
BME608A2	COMPUTATIONAL FLUID DYNAMICS LAB	BME608A4	IIOT LAB

Note: BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses. **UHV:** Universal Human Value Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **MC:** Mandatory Course

L – Lecture, **T –** Tutorial, P- Practical/ Drawing, **S –** Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB**: Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Professional Elective Course (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 20. However, this conditional shall not be applicable to cases where the admission to the program is less than 20.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an Open Elective shall not be allowed if,

i. The candidate has studied the same course during the previous semesters of the program.
ii. The syllabus content of open electives is similar to that of the Departmental core courses or Professional Elective courses.
iii. A similar course, under any category, is prescribed in the higher semesters of the program.
iv. In case, if any department is interested in offering courses from streams such as Law, Business (MBA), Medicine, Arts, Commerce etc. need to get the necessary approval from the respective Board of Studies and the Academic Council.
v. The minimum numbers of students' strength for offering Open Elective Course is 20. However, this condition shall not be applicable to class where the admission to the program is less than 20.

Project Work Phase I (PW): Students have to discuss with their mentors/guides and with their help has to complete the Literature Review, define the problem statement for the Project Work, and submit appropriate report. The guidelines and the evaluation process will be defined by the Project Evaluation Committee (PEC) of the department and approved by the Board of Studies and the Academic Council of SCEM.

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2024

OUTCOME BASED EDUCATION(OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

VII SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours/ Week				Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	IPCC	BME701G	CONTROL ENGINEERING	ME	ME	03	00	02	03	03	50	50	100	04
2	PCC	BME702T	DESIGN OF MACHINE ELEMENTS – II	ME	ME	03	00	00	03	03	50	50	100	03
3	PEC	BME703Ex	PROFESSIONAL ELECTIVE COURSE	ME	ME	03	00	00	03	03	50	50	100	03
4	OEC	BME704Qx	OPEN ELECTIVE COURSE	ME	ME	03	00	00	03	03	50	50	100	03
5	PCCL	BME705L	COMPUTER INTEGRATED MANUFACTURING LAB	ME	ME	00	00	02	00	03	50	50	100	01
6	PROJ	BME706P	PROJECT WORK PHASE II	ME	ME	00	00	02	10	03	50	50	100	06
									TOTAL		**300**	**300**	**600**	**20**

PROFESSIONAL ELECTIVE COURSE

BME703E1	OPERATIONS AND SUPPLY CHAIN MANAGEMENT	BME703E3	ROCKET PROPULSION
BME703E2	AUTOMOTIVE ENGINEERING	BME703E4	NANOTECHNOLOGY

OPEN ELECTIVE COURSE

BME704Q1	ENERGY AND ENVIRONMENT	BME704Q3	PRODUCT DESIGN AND MANUFACTURING
BME704Q2	BUSINESS PLANNING AND PROJECT MANAGEMENT	BME704Q4	INTRODUCTION TO HYDRAULICS AND PNEUMATICS

Note: BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses. **UHV:** Universal Human Value Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **MC:** Mandatory Course

L – Lecture, **T –** Tutorial, P- Practical/ Drawing, **S –** Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB**: Paper Setting Board.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIA and SEE. The practical part shall be evaluated by only CIA (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Professional Elective Course (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 20. However, this conditional shall not be applicable to cases where the admission to the program is less than 20.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an Open Elective shall not be allowed if,

i. The candidate has studied the same course during the previous semesters of the program.
ii. The syllabus content of open electives is similar to that of the Departmental core courses or Professional Elective courses.
iii. A similar course, under any category, is prescribed in the higher semesters of the program.
iv. In case, if any department is interested in offering courses from streams such as Law, Business (MBA), Medicine, Arts, Commerce etc. need to get the necessary approval from the respective Board of Studies and the Academic Council.
v. The minimum numbers of students' strength for offering Open Elective Course is 20. However, this condition shall not be applicable to class where the admission to the program is less than 20.

Project Work Phase II (PW): The objective of the Project Work is to

i. Encourage independent learning and the innovative attitude of the students
ii. Develop interactive attitude, communication skills, Organization, Time Management and Presentation Skills.
iii. Impart Flexibility and Adaptability
iv. Inspire Team working
v. Expand Intellectual capacity, credibility, judgment and intuition
vi. Adhere to Punctuality, setting and meeting deadlines
vii. Install responsibilities to oneself and others
viii. Train students to present the topic of Project work without any fear, face the audience confidently, enhance communication skills, involve in group discussions to present and exchange ideas.

The evaluation of the Project Work Phase II shall contain both Continuous Internal Assessment (CIA) and Semester End Examination (SEE). The guidelines and the evaluation process will be defined by the Project Evaluation Committee (PEC) of the department and approved by the Board of Studies and the Academic Council of SCEM.

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in MECHANICAL ENGINEERING

SCHEME OF TEACHING AND EVALUATION 2024

OUTCOME BASED EDUCATION(OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)

(2024 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2024 - 25)

VIII SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD)	Question Paper Setting Board (PSB)	Teaching Hours/ Week				Examination				Credits
						Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIA Marks	SEE Marks	Total Marks	
						L	T	P	S					
1	PEC	BME801Ex	PROFESSIONAL ELECTIVE COURSE- IV (12 WEEKS NPTEL) *	NPTEL		00	00	00	06	AS PER GUIDELINES OF NPTEL				03
2	OEC	BME802Qx	OPEN ELECTIVE COURSE- III (12 WEEKS NPTEL) *	NPTEL		00	00	00	06	AS PER GUIDELINES OF NPTEL				03
3	INT	BME803I	INTERNSHIP (14-20 WEEKS) RESEARCH INTERNSHIP/ INDUSTRY INTERNSHIP/ RURAL INTERNSHIP	ME	ME	00	00	00	18	03	50	50	100	09
4	SEM	BME804S	RESEARCH ORIENTED TECHNICAL SEMINAR	ME	ME	00	00	00	02	03	50	--	50	01
									TOTAL		**100**	**50**	**150**	**16**

***To be published by the Board of Studies of _____**

Note: BSC: Basic Science Course, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PCCL:** Professional Core Course Laboratory, **AEC:** Ability Enhancement Courses. **UHV:** Universal Human Value Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **MC:** Mandatory Course

L – Lecture, **T –** Tutorial, P- Practical/ Drawing, **S –** Self -Study Component, **CIA:** Continuous Internal Assessment, **SEE:** Semester End Examination, **TD-** Teaching Department, **PSB**: Paper Setting Board.

Professional Elective Course (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course.

1. The PEC-IV shall be completed by the student in the form of online course, offered by NPTEL (STRICTLY) only
2. The courses shall be identified and approved by the BoS. In the case of modification, the chairperson of the BoS shall notify the updated course(s) to the concerned appropriately
3. The chosen course should not have been completed either in the MINORS or HONORS degree. If chosen and completed, then such course(s) shall automatically be cancelled and the candidates shall have to opt other courses from the BoS published list of course(s)
4. The student shall complete the course at any time between the FIFTH semester and the SEVENTH semester
5. The student has to provide the evidences for registering to the course, assignment submission, attending the examination and the certificate provided by the course provider indicating the clearance of the course by the candidate.
6. Only on submitting the valid documents, the student will be awarded with the credits mentioned against the course(s) and the same shall be reflected in the EIGHTH semester grade card
7. The EIGHTH semester marks card shall be provided to the student only on the completion of all the course(s) mentioned in the Eighth semester of the 2024-Scheme of Teaching and Evaluations.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an Open Elective shall not be allowed if,

1. The candidate has studied the same course during the previous semesters of the program
2. The syllabus content of open electives is similar to that of the Departmental core courses or Professional Elective courses
3. The courses shall be identified and approved by the BoS. In the case of modification, the chairperson of the BoS shall notify the updated course(s) to the concerned appropriately
4. The chosen course should not have been completed either in the MINORS or HONORS degree. If chosen and completed, then such course(s) shall automatically be cancelled and the candidates shall have to opt other courses from the BoS published list of course(s)
5. The student shall complete the course at any time between the FIFTH semester and the SEVENTH semester
6. The student has to provide the evidences for registering to the course, assignment submission, attending the examination and the certificate provided by the course provider indicating the clearance of the course by the candidate
7. Only on submitting the valid documents, the student will be awarded with the credits mentioned against the course(s) and the same shall be reflected in the EIGHTH semester grade card
8. The EIGHTH semester marks card shall be provided to the student only on the completion of all the course(s) mentioned in the Eighth semester of the 2024-Scheme of Teaching and Evaluations.

Research Internship/ Industry Internship/ Rural Internship

- **Research Internship:** This is intended to offer the flavor of current research happening in the Research fields. It helps students to get familiarize with the field and imparts the skill required for carrying out research.
- **Industry Internship:** An extended period of work experience undertaken by the students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate the organizations, perspectives and cultures. Dealing with contingencies helps the students recognize, appreciate and adapt to the organizational realities by tempering their knowledge with practical constraints.
- **Rural Internship:** A long term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity.
- The student may take up Interdisciplinary Research Internship or Industry Internship.
- The Faculty Mentor need to monitor the student's internship progress and interact with them to guide them for the successful completion of the internship requirements
- The students are permitted to carry out internship anywhere in India or Abroad. However, the institute will not bear any expenses incurred with respect to the internship.

Research Oriented Technical Seminar: In order to make the student aware of the technological and research application in various domains of the society, a comprehensive presentation need to be provided with all the supporting evidences for the claims in the presentation.

- The objective of the Technical Seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas.
- Each student, under the guidance of a Faculty, shall choose a topic, preferably a recent topic in their interested specializations.
- The student has to
  i. Carry out a detailed Literature survey, systematically organize the content
  ii. Prepare the report as per their own intuition, without cut-paste activities.
  iii. Use tools for writing equations, drawings etc. and gain proficiency of the tools used.
  iv. Present the topics effectively through appropriate digital media.
  v. Answer the queries posed and involve in healthy debates/discussions
  vi. Submit a report in an error-free and professional way
  vii. Present the findings of the seminar in the reputed Conferences/Journals for possible publications (desirable).
- The evaluation procedure for the Research oriented Technical Seminar will be as provided by the Board of Studies and approved by the Academic Council of SCEM.

NUMERICAL METHODS AND TRANSFORM TECHNIQUES

(Effective from the Academic Year 2025- 2026)

SEMESTER – III

Course Code	**BMA301TM**	**CIA Marks**	**50**
Number of Contact Hours/Week (L:T:P:S)	**3:0:0:1**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Exam Hours**	**3 Hours**

CREDITS – 3

COURSE PREREQUISITES:

- Applied Mathematics-I, Applied Mathematics-II

COURSE OBJECTIVES:

- Develop accurate solutions for initial value problems and Partial Differential Equations using various Numerical Techniques.
- Enable the students to use the concepts of the Fourier series and transforms to solve engineering problems
- Study the various methods of Transform Calculus of continuous and discrete variables.

TEACHING - LEARNING STRATEGY:

The following are some sample strategies that can be incorporated for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem-Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE – I

Numerical solution of ODEs **Numerical solution of ODEs of first order and first degree –** Taylor's series method, modified Euler's method. Runge-Kutta method of fourth order, Milne's, and Adam-Bashforth predictor and corrector method. **Numerical Solution of Second Order ODEs:** Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).	**8 Hours**

MODULE – II

Numerical Solution of Partial Differential Equations: Classifications of second-order partial differential equations, finite difference approximations to derivatives, and the solution of Laplace's equation using the standard five-point formula. Solution of the heat equation by the Schmidt explicit formula and Crank- Crank-Nicolson method and the solution of the wave equation. Application of Partial Differential Equations.	**8 Hours**

MODULE – III

Fourier series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions of 2π and arbitrary period. Half-range Fourier series. Practical Harmonic Analysis and Applications.	**12 Hours**

MODULE – IV

Fourier transforms and Z-Transforms: **Fourier transform** infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms—application of the Fourier transforms. **Z-Transforms:** Standard z-transforms, damping and shifting rules, initial value and final value theorems (without proof), and problems. Inverse z-transform and applications to the solution of difference equations. Standard z-transforms, damping and shifting rules, inverse z-transforms, and applications to solve difference equations.	**12 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Solve first and second-order ordinary differential equations using single-step and multistep numerical methods for engineering problems	CL3
CO2	Solve partial differential equations using classification techniques, finite difference methods, and numerical schemes for practical applications.	CL3
CO3	Illustrate the behaviour of the Fourier series and their applications in communication systems.	CL3
CO4	Apply Fourier and Z-transform techniques, including inverse transforms and related theorems, to solve differential and difference equations in engineering applications.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)											Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	1		3	1					1	2	1	1
CO2	3	3	1		3	1					1	2	1	2
CO3	3	2	1		2	1					1	1	1	1
CO4	3	3	1		2	1					1	2	1	1

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS				
Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate
Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from the first and second module.
- In Part B, the Question 4 and 5 will be from Module 3 and Question 6 and 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, they will have a choice in Modules 3 and 4.

REFERENCE BOOKS:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017, May.
2. N.P Bali and Manish Goyal: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022
3. B.V. Ramana: "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017
4. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw – Hill Book Co., New York, 6th Ed., 2017.
5. E.Kreyszig: "Advanced Engineering Mathematics", John Wiley and Sons, 10thEd.(Reprint), 2016.

6. Dr. K Chandrashekar, "Transform Calculus and Numerical Techniques" Sudha Publications,2019.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. http://www.bookstreet.in.
5. VTU e-Shikshana Program.
6. https://youtu.be/6HeQc7CSkZs
7. https://youtu.be/B4IyRw1zvvA

BASIC THERMODYNAMICS

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BME302G**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of Mathematics and Elements of Mechanical Engineering.

COURSE OBJECTIVES:

- Learn about thermodynamic system and its equilibrium.
- Understand various forms of energy – heat and work transfer.
- Study the laws of thermodynamics including, zeroth law, first law and second law.
- Interpret the behaviour of pure substances and its application in practical problems.
- Study of Ideal and real gases and evaluation of thermodynamic properties.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Fundamental Concepts & Definitions: Thermodynamics definition, Microscopic and Macroscopic approaches, thermodynamic system, boundary and control surface, examples. Thermodynamic properties; intensive and extensive properties, Thermodynamic state, path and process, quasi-static process, cyclic and non-cyclic processes, Thermodynamic equilibrium; definition, mechanical equilibrium, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, temperature scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer. Numericals on temperature scales.	**10 Hours**

MODULE - II

Work and Heat: work according to Mechanics, Thermodynamic definition of work; examples, sign convention. Displacement work; expressions for displacement work in various processes through PV diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Numericals on different displacement works. **First Law of Thermodynamics:** Joule's experiment, Statement of the First law of thermodynamics, extension of the First law to non-cyclic processes, energy, energy as a property, modes of energy, Availability (Exergy), Unavailable energy, Extension of the First law to control volume; steady flow energy equation (SFEE), important applications. Numericals on first law applicable to both Non-flow and flow processes.	**10 Hours**

MODULE - III

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pumps: Schematic representation, efficiency and COP. Kelvin-Planck statement of the Second law of Thermodynamics; PMM-I and PMM-II kind, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles, Numericals. Definition of Entropy and mathematical expression.	**10 Hours**

MODULE - IV

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (Quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Numericals. **Ideal gases:** Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties. Numericals. **Real gases:** Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases. Numericals.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze thermodynamic systems and processes using fundamental concepts such as thermodynamic properties, equilibrium, and temperature scales to determine the state and behavior of systems.	CL4
CO2	Examine types of heat and work interactions, and assess energy exchanges in both closed and open systems using the First Law of Thermodynamics.	CL4
CO3	Analyze heat engine and refrigeration cycles using the Second Law of Thermodynamics, and evaluate their performance.	CL4
CO4	Analyze the thermodynamic properties of pure substances and gas mixtures using appropriate charts and equations of state to evaluate phase changes and deviations from ideal gas behavior.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Measurement of temperature using mercury in glass thermometer and thermocouple to evaluate international fixed points and scales.	CO1	CL4
2.	Experimentation on power producing thermodynamic system (IC Engine) to evaluate the energy interactions and sign conventions.	CO2	CL4
3.	Experimentation on power absorbing thermodynamic system (Vapour compression Refrigerator) to evaluate the energy interactions and sign conventions.	CO2	CL4
4.	Demonstration on flow processes in power producing thermodynamic systems – I C Engine, Hydraulic turbines.	CO2	CL2
5.	Demonstration on flow processes in power absorbing thermodynamic systems – Pumps, Blower.	CO2	CL2
6.	Demonstration on flow processes in non-power producing and non-power absorbing thermodynamic systems – Heat exchanger, nozzle.	CO2	CL2
7.	Determine the Calorific value of the fuel by using Bomb Calorimeter.	CO2	CL4
8.	Demonstration on Performance parameters of Power producing and Power absorbing devices.	CO3	CL2
9.	Experimentation on boiling heat transfer to understand stages of steam formation.	CO4	CL2
10.	Demonstration on application of Ideal and Real Gases	CO4	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1							1		1			3
CO2	3	3	1							1		1			3
CO3	3	3	1							1		1			3
CO4	3	3	1							1		1			3

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. P. K. Nag, Engineering Thermodynamics, 6th ed., New Delhi: Tata McGraw Hill, 2018.
2. Y. A. Çengel, M. A. Boles & M. Kanoglu, Thermodynamics: An Engineering Approach, 10th ed., New York: McGraw-Hill, circa 2025.
3. V. Kadambi, T. R. Seetharam & K. B. Subramanya Kumar, Applications of Thermodynamics, 1st ed., New Delhi: Wiley India Pvt. Ltd., 2019.
4. B. K. Venkanna & S. B. Wadavadagi, Basic Thermodynamics, 1st ed., New Delhi: PHI Learning Pvt. Ltd., 2010.
5. G. J. Van Wylen & R. E. Sonntag, Fundamentals of Classical Thermodynamics, 5th ed., New Delhi: Wiley Eastern, 2004.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (If Any):

1. https://onlinecourses.nptel.ac.in/noc21_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_me119/preview
3. https://nptel.ac.in/courses/112105266

MATERIAL SCEINCE AND METALLURGY
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BME303G**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Elements of Mechanical Engineering, Engineering Mathematics, Engineering chemistry

COURSE OBJECTIVES:

- Understand the behavior of materials common in mechanical engineering.
- Explore the mechanical properties of metals and their alloys, polymers, ceramics, composites
- Construct and interpret phase diagrams for binary alloy systems
- Understand modifications of material properties by heat treatment processes
- Gain exposure to the concept of corrosion and it's methods of prevention
- Understand techniques such as powder metallurgy and its applications

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Classification of materials, crystalline and non-crystalline solids, Crystal Structure – Coordination number, atomic packing factor of simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections – point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion; Factors affecting diffusion. Mechanical Behavior: Stressstrain diagrams showing ductile and brittle behavior of materials, Mechanical properties in plastic range. Fracture: Type I, Type II and Type III, Fatigue: Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing. Creep: Description of the phenomenon with examples, three stages of creep, creep properties	**10 Hours**

MODULE - II

Solidification and Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), phase diagrams: Isomorphous, Eutectic, and Eutectoid systems, Lever rule, Intermediate phases, Gibbs phase rule, Iron-Carbon (Cementite) diagram: description of phases, Solidification: Mechanism of solidification, Homogenous and 8 Hours Heterogeneous nucleation.	**10 Hours**

MODULE - III

Heat Treatment, Ferrous and Non-Ferrous Alloys Heat treating of metals: Time-Temperature Transformation (TTT) curves, Annealing: Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminum-copper alloys Ferrous materials: Properties, Compositions and uses of grey cast	**10 Hours**

iron and steel.	

MODULE - IV

Powder Metallurgy: Definition and concepts, applications, powder metallurgy process, production of metal powders; Different Mechanical methods: Chopping or Cutting, Abrasion methods, Machining methods, Ball Milling and Chemical method: Chemical reduction method **Composite Materials**: Definition, applications and properties of MMCs, ceramic composites and FRPs Production of Metal Matrix Composites (Squeeze casting, powder metallurgy, stir casting) Production of FRPs (Hand layup, spray layup, pultrusion, filament winding, SMC	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the concept of atomic packing factor and be able to describe mechanical behavior of materials	CL2
CO2	Construct phase diagrams of eutectic systems and be able to interpret Iron-Iron carbide diagram	CL2
CO3	Construct TTT diagram and understand various heat treatment process in properties	CL4
CO4	Understand the principles of powder metallurgy and composites, its process and application	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Evaluate hardness of untreated and heat-treated specimens using Brinell, Rockwell and Vickers's Hardness testing machine	1	CL3
2.	Evaluate modulus of rigidity, torsional yield strength of steels using Torsion testing machine	2	CL3
3.	Izod and charpy test for of untreated and heat-treated specimens	1, 2	CL3
4.	Evaluate mechanical properties of engineering materials using Universal Testing Machine	3	CL4
5.	Annealing, normalizing, hardening and tempering of steel. Metallographic specimens of heat-treated components to be supplied and students should report microstructures of furnace cooled, water cooled, air cooled, tempered steel. Students should be able to distinguish the phase changes in a heat-treated specimen compared to untreated specimen (DEMO)	3	CL4
6.	Fabrication of Fibre reinforced composites using land lay-up methods (Demonstration)	3	CL4
7.	Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites (Demonstration)	3	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)	Programme Specific Outcome (PSO)

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3							2		2		2	
CO2	3	3	3	2	2				2	2		2		2	
CO3	3	3	3	2	2				2	2		2		2	
CO4	3	3	3							2		2		2	

3: Substantial (High)	**2: Moderate (Medium)**	**1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. V.Raghavan, Materials Science and Engineering, , PHI, 2002
2. Donald R. Askland and Pradeep.P. Phule, The Science and Engineering of Materials, Cengage Learning, 4lh Ed., 2003.
3. Foundations of Material Science and Engineering by Smith,Mcgrawhill, 4th edition 2009
4. Material science and Engineering Introduction by William D Callister, Wiley, 2006

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (If Any)

1. https://www.youtube.com/watch?v=OQ3SSnmOieQ
2. https://www.youtube.com/watch?v=wVZkdWEZv80

MECHANICS OF MATERIALS

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BME304T**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Engineering Mechanics.

OURSE OBJECTIVES:

- Classify the stresses into various categories and define elastic properties of materials and compute stress and strain intensities caused by applied loads in simple and compound sections and temperature changes.
- Derive the equations for principal stress and maximum in-plane shear stress and calculate their magnitude and direction. Draw Mohr's circle for plane stress system and interpret this circle.
- Determine the shear force, bending moment and draw shear force and bending moment diagrams, describe behavior of beams under lateral loads.
- Explain the structural behavior of members subjected to torque, calculate twist and stress induced in shafts subjected to bending and torsion
- Understand the concept of stability and derive crippling loads for columns.
- Understand the concept of strain energy and compute strain energy for applied loads.

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Stress and Strain: Introduction, Hooke's law, Mechanical Properties of Engineering Materials, Stress-strain diagram for Engineering Materials, Calculation of stresses in straight, Stepped and tapered sections, Superposition principles, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's Ratio, Generalized Hooke's law, Bulk modulus, Relationship between elastic constants.	**10 Hours**

MODULE - II

Analysis of Stress and Strain: Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr's circle for plane stress conditions. **Cylinders**: Thin cylinder: Hoop's stress, maximum shear stress, Circumferential and longitudinal strains, thick cylinders: Lame's equations. **Theories of Failure**: Maximum Principal stress theory, Maximum shear stress theory	**10 Hours**

MODULE - III

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads.	**10 Hours**

Stress in Beams: Pure bending, Curvature of a beam, Longitudinal strains in beams, Normal stresses in Beams with rectangular, circular, 'I' and 'T' cross sections, Flexure Formula, Bending Stresses.	
MODULE - IV	
Torsion: Circular solid and hollow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections. **Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns. **Strain Energy**: Strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze stresses and strains developed in the member subjected to axial, bending, shear, torsion & thermal loads.	CL4
CO2	Analyze the graphical representation of stresses and strains and understand the concept of stress developed in the thick and thin cylinders.	CL4
CO3	Analyze the shear force and bending moment diagrams in beams subjected to different loading conditions and bending stress and shear stress developed for different types of beams.	CL4
CO4	Analyze the torsional stress, angle of twist and power transmitted for shafts subjected to pure torsion and the buckling of Columns subjected to different load and end conditions.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2					2	2	2		2	2		
CO2	3	3	2					1		1		2	2		
CO3	3	3	2		2			2	2	2		2	2		
CO4	3	3	2					1		1		2	2		

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. J M Gere, B J Goodno, “Mechanics of Materials” Cengage, Eighth edition 2013.
2. P N Chandramouli “Fundamentals of Strength of Materials” PHI Learning Pvt. Ltd, 2013.
3. R K Rajput “Strength of Materials” s. Chand and Company Pvt. Ltd, 2014.
4. R. Subramanian “Strength of Materials” Oxford, 2005.
5. S. S. Ratan “Strength of Materials” Tata McGraw Hill 2nd Edition, 2008.
6. S C Pilli and N Balasubramanya “Mechanics of materials Strength of Materials” Cengage 2019..

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://onlinecourses.nptel.ac.in/noc22_ce54/
2. https://nptel.ac.in/courses/105104160

MEASUREMENT AND METROLOGY LABORATORY

(Effective from the Academic Year 2023 - 2024)

SEMESTER - III

Course Code	**BME305L**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of least count, scale reading techniques.
- Knowledge on basic measurement instruments.

COURSE OBJECTIVES:

- To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
- To illustrate the use of various measuring tools & measuring techniques.
- To understand calibration techniques of various measuring devices.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Calibration of micrometer and vernier caliper using slip gauges.
2	Calibration of pressure Gauge.
3	Calibration of LVDT.
4	Calibration of load cell.
5	Calibration of thermocouple.
6	Measurement of angle using sine centre, sine bar and bevel protractor.
7	Measurements using optical projector and tool makers' microscope.
8	Measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2- wire and 3-wire methods, Sheet and wire gauge.
9	Gear tooth measurement using gear tooth vernier and gear tooth micrometer.
10	Determination of modulus of elasticity of a mild steel specimen using strain gauge.
11	Surface topology measurement using surface roughness tester.
12	Demonstration of measurement using coordinate measuring machine (CMM).

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Demonstrate the calibration of various measuring gauges.	CL3
CO2	Choose appropriate measuring instruments to discover angular measurement of a given object.	CL3

CO3	Analyze the application of optical and manual instruments to measure the profile of threaded parts.	CL4
CO4	Analyze the application of gear tooth vernier and gear tooth micrometer to measure the profile of the gears.	CL4
CO5	Explain the applications of strain gauge, surface roughness tester and coordinate measuring machines.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		3			2	2	1		2		3	2
CO2	3	3	2		3			2	2	1		2		3	
CO3	3	3	2		3			2	2	1		2	2	3	
CO4	3	3	2		3			2	2	1		2	2	3	
CO5	3	3	2		3			2	2	1		2	2	3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. Engineering Metrology and Measurements, N.V. Raghavendra and L. Krishnamurthy, Oxford University Press, 2013.
2. Mechanical, Measurements and Instrumentation, R.K Rajput, S.K. Kataria & Sons, 3rd Edition.
3. http://vlabs.iitb.ac.in/vlabs-
4. https://www.digimat.in/nptel/courses/video/112106138/L01.html

MANUFACTURING TECHNOLOGY
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BME306W1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basics of Engineering Materials: Understanding of material types, properties (mechanical, thermal, and electrical), and basic material science concepts.
- Engineering Mechanics: Knowledge of forces, stress, strain, and deformation in materials.
- Workshop Practice: Familiarity with basic tools and operations such as fitting, turning, and drilling (introductory workshop training).

COURSE OBJECTIVES:

- To explain the classification, significance, and material aspects of various manufacturing processes used in industry.
- To describe the fundamental principles, components, and common defects associated with different metal casting techniques.
- To understand the working principles and industrial relevance of major metal forming operations such as rolling, forging, extrusion, and drawing.
- To examine the operational principles, applications, and future trends of welding and additive manufacturing technologies in modern production systems.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to Manufacturing Process: classification of manufacturing processes (casting, forming, machining, welding, additive manufacturing), significance of manufacturing in the economy and industry, materials used in manufacturing (metals, polymers, ceramics, composites), mechanical properties of materials (strength, hardness, toughness, ductility, etc.), criteria for material selection in manufacturing processes.	**10 Hours**

MODULE - II

Basics of Metal Casting (definition, advantages, and applications), components of casting systems (patterns, molds, gating systems, risers), types of casting processes (sand casting, die casting, investment casting, centrifugal casting), defects in casting processes (causes, identification, and prevention),	**10 Hours**

MODULE - III

Metal Forming Processes (overview and classification), rolling (principles, types, and applications), forging (open-die and closed-die forging), extrusion (types: direct, indirect, and hydrostatic), drawing processes (wire drawing and tube drawing), defects in forming processes and their remedies.	**10 Hours**

MODULE - IV

Welding Processes (overview and classification), arc welding (principle, equipment, and applications), TIG welding (advantages and limitations), MIG welding (applications and process details), laser welding (working and industrial usage), soldering and brazing (differences, materials used, and applications), adhesive bonding (introduction and applications in manufacturing), **Additive Manufacturing** (definition and significance), types of additive manufacturing (fused deposition modeling (FDM), selective laser sintering (SLS), stereolithography (SLA)), applications of	**10 Hours**

additive manufacturing (prototyping, customized products, mass production), advantages of additive manufacturing in modern industries, future trends in welding and additive technologies.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Demonstrate the selection of appropriate manufacturing processes and materials based on their properties and industrial requirements.	CL3
CO2	Illustrate the components and operations of various casting processes to identify suitable methods and reduce defects.	CL3
CO3	Apply metal forming principles to select suitable processes for shaping components in industrial manufacturing.	CL3
CO4	Apply appropriate welding and additive manufacturing processes for efficient fabrication of products in modern industries.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				2				3		2	
CO2	3	3	2					2				2		3	
CO3	3	3	3					2				3		2	
CO4	3	3	2					2				2		3	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05

2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

- S. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology, 7th ed., Pearson Education, 2014.
- P. N. Rao, Manufacturing Technology: Foundry, Forming and Welding, Vol. 1, 4th ed., Tata McGraw-Hill, 2013.
- P. N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, Vol. 2, 4th ed., Tata McGraw-Hill, 2013.
- M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th ed., John Wiley & Sons, 2019.
- R. S. Parmar, Welding Processes and Technology, 3rd ed., Khanna Publishers, New Delhi, 2004.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. **https://archive.nptel.ac.in/courses/112/107/112107077/**
2. https://archive.nptel.ac.in/courses/112/107/112107145/

MECHATRONICS
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BME306W2**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering, Basic Electronics

COURSE OBJECTIVES:

- To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
- To understand the evolution and development of Mechatronics as a discipline.
- To substantiate the need for interdisciplinary study in technology education
- Understand the applications of microprocessors in various systems and to know the functions of each element.
- To demonstrate the integration philosophy in view of Mechatronics technology
- To be able to work efficiently in multidisciplinary teams

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

INTRODUCTION: Definition of Mechatronics, Multi-disciplinary scenario, Evaluation of Mechatronics, Objectives, Advantages & Disadvantages of Mechatronics, An Overview of Mechatronics, Microprocessor Based Controllers, Principle of Working of Automatic Camera, Automatic Washing Machine & Engine Management System.	**10 Hours**

MODULE - II

REVIEW OF SENSORS AND TRANSDUCERS: Definition and Classification of Transducers, Definition & Classification of Sensors, Working Principle and Application of Displacement, Position & Proximity, Velocity and Motion, Force, Fluid pressure, Liquid flow, Liquid level, Temperature, Light sensors, Selection of transducers.	**10 Hours**

MODULE - III

DIGITAL PRINCIPLES: Introduction, Digital Number System, Range and Weight of Binary Number System, Octal and Hexadecimal Number Systems, Conversion, BCD Number Systems, Gray Code, Boolean Algebra, Logic gates, Logic Functions, More Logic Gates, Universal Gates, Exclusive-OR Gate, Combinational and Sequential Logic Circuits, Flip- Flops.	**10 Hours**

MODULE - IV

MICROPROCESSOR: Intel 8085, ALU, Timing and Control Unit, Registers, Data and Address Bus, Pin Configuration, Intel 8085 Instructions, Op code and Operands, Timing Diagram. **PROGRAMMING OF MICROPROCESSOR**: Programming the 8085, Assembly language programming **MICRO CONTROLLER**: Introduction to microcontrollers, Intel 8051 Microcontroller Architecture and Pin diagram, Selection and Application of Microcontroller.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Define the concept of Mechatronics and explain its multidisciplinary nature, applications, objectives, advantages and disadvantages, and the working of basic automated systems.	CL2
CO2	Classify and explain the working principles of various sensors and transducers used in Mechatronic systems, and select appropriate sensors for specific applications.	CL2
CO3	Understand and apply digital logic principles, number systems, Boolean algebra, and logic gates for designing simple combinational and sequential circuits.	CL2
CO4	Describe the architecture and operation of Intel 8085 and 8051, write basic assembly language programs, and identify the application areas of microcontrollers in Mechatronic systems	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2									2		2	
CO2	3	2	2									2		2	
CO3	3	2	2									2		2	
CO4	3	2	2									2		2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

- Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering by W. Bolton,Pearson Education Edition: 6th edition
- Mechatronics: Principles and Applications by Godfrey C. Onwubolu, Elsevier/Elsevier Academic Press
- Introduction to Mechatronics and Measurement Systems, David G. Alciatore and Michael B. Histand McGraw-Hill Education
- The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin McKinlay, Pearson Education
- Digital Principles and Applications, Donald P. Leach, Albert Paul Malvino, McGraw-Hill Education

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

MECHANICAL MEASUREMENTS AND METROLOGY

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	BME306W3	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic understanding of engineering physics and mechanics, including force, pressure, temperature, and motion.
- Knowledge of calculus and basic statistics is essential for measurement analysis and error calculation.
- Familiarity with basic instruments like vernier callipers and micrometres.

COURSE OBJECTIVES:

- To introduce the principles and objectives of metrology, material standards, and methods of linear and angular measurement.
- To explain the structure and characteristics of measurement systems, and classify types of errors in measurements.
- To provide knowledge on the measurement of force, torque, pressure, strain, and temperature using mechanical and electronic instruments.
- To understand the concepts of limits, fits, tolerances, and the working of various types of comparators used in precision measurement.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to Metrology: Definition, objectives of metrology, material Standards, wavelength standards, classification of standards, line and end standards, calibration of and bars, numerical examples. **Liner measurement and angular measurements:** Slip gauges - Indian standards on slip gauges, adjustable slip gauges, Wringing of slip gauges, Problems on building of slip gauges (M87, M112), Measurement of angle - sine bar, sine centre, angle gauges, optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.	**10 Hours**

MODULE - II

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, generalized measurement system, Static characteristics - Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. **Intermediate Modifying and Terminating Devices**: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.	**10 Hours**

MODULE - III

Measurement of force, torque, and pressure: Principle of analytical balance, proving ring. Torque measurement, Prony brake, Hydraulic dynamometer. Pressure measurements, Use of elastic members, Bridgeman gauge, McLeod gauge**.**	**10 Hours**

Measurement of strain and temperature: Thermocouple, law of thermocouple, materials used for construction, Pyrometer, Optical Pyrometer. Strain Measurements, Strain gauge preparation and mounting of strain gauges, gauge factor. Berry strain gauge, electrical resistance strain gauge.	

MODULE - IV

System of Limits, Fits, Tolerance and Gauging: Definition of tolerance and its specification in assembly, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation, Principle of interchangeability and selective assembly, limits of size, standards, hole basis system, shaft basis of system. Numerical problems on limit fits and tolerances. **Comparators:** Functional requirements, Classification, Mechanical - Johnson Mikrokator, Sigma comparators, Dial indicator, Electrical comparators, LVDT, Pneumatic comparators- Principle of back pressure, Solex comparators, Optical comparators- Zeiss ultra- optimeter.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Describe the principles of metrology and apply linear and angular measurement techniques using relevant tools.	CL2
CO2	Explain the basic structure of a measurement system, its key characteristics, and the types and sources of measurement errors.	CL2
CO3	Select appropriate instruments for measuring force, torque, pressure, strain, and temperature in engineering applications.	CL2
CO4	Apply concepts of limits, fits, and tolerances in design and evaluate the performance of mechanical, electrical, pneumatic, and optical comparators.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2					2		2		3	3	3	
CO2	3	2	2					2		2		3	3	3	
CO3	3	2	2					2		2		3	3	3	
CO4	3	2	2					2		2		3	3	3	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Mechanical Measurements", Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. "Engineering Metrology", R.K. Jain, Khanna Publishers, Delhi, 2009.
3. "A Textbook of Measurements and Metrology", M.Mahajan, Dhanpat Rai &Co., 2014.
4. "Mechanical measurements & Metrology", Dr. T Chandrashekhar.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. https://nptel.ac.in/courses/112104250

WASTE HANDLING AND MANAGEMENT

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BME306W4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering

COURSE OBJECTIVES:

- To learn broader understandings on various aspects of solid waste management practiced in industries.
- To learn recovery of products from solid waste to compost and biogas, incineration and energy recovery, hazardous waste management and treatment, and integrated waste management.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

INTRODUCTION TO SOLID WASTE MANAGEMENT: Classification of solid wastes (source and type based), solid waste management (SWM), elements of SWM, ESSWM (environmentally sound solid waste management) and EST (environmentally sound technologies), factors affecting SWM, Indian scenario, progress in MSW (municipal solid waste) management in India.Indian and global scenario of e-waste. **WASTE GENERATION ASPECTS:** Waste stream assessment (WSA), waste generation and composition, waste characteristics (physical and chemical), health and environmental effects (public health and environmental), comparative assessment of waste generation and composition of developing and developed nations, a case study results from an Indian city, handouts on solid waste compositions. E-waste generation.	**10 Hours**

MODULE - II

COLLECTION, STORAGE, TRANSPORT AND DISPOSAL OF WASTES: Waste Collection, Storage and Transport: Collection components, storage-containers/collection vehicles, collection operation, transfer station, waste collection system design, record keeping, control, inventory and monitoring, implementing collection and transfer system, a case study. Waste Disposal: key issues in waste disposal, disposal options and selection criteria, sanitary landfill, landfill gas emission, leachate formation, environmental effects of landfill, landfill operation issues, a case study.	**10 Hours**

MODULE - III

WASTE PROCESSING TECHNIQUES & SOURCE REDUCTION, PRODUCT RECOVERY & RECYCLING: Purpose of processing, mechanical volume and size reduction, component separation, drying and dewatering. Source Reduction, Product Recovery and Recycling: basics, purpose, implementation monitoring and evaluation of source reduction, significance of recycling, planning of a recycling Programme, recycling programme elements, commonly recycled materials and processes, a case study.	**10 Hours**

MODULE - IV

HAZARDOUS WASTE MANAGEMENT AND TREATMENT: Identification and classification of hazardous waste, hazardous waste treatment, pollution prevention and waste minimization, hazardous wastes management in India. E-waste recycling.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the classification, sources, and types of solid waste, and explain the components and environmental aspects of solid waste management including ESSWM, EST, and e-waste scenarios in India and globally.	CL2
CO2	Explain the methods and design considerations for solid waste collection, storage, transportation, and disposal, including sanitary landfills and their environmental impacts.	CL2
CO3	Understand the objectives and techniques of waste processing, and describe the fundamentals and significance of source reduction, material recovery, and recycling programs.	CL2
CO4	Explain the identification, classification, and treatment of hazardous waste, and understand the methods of pollution prevention, waste minimization, and e-waste recycling in the Indian context.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3			2	2								3
CO2	3	3	3			2	2								3
CO3	3	3	3			2	2								3
CO4	3	3	3			2	2								3

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03

5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses– Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. G. Tchobanoglous, H. Theisen, and S. A. Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, New York: McGraw-Hill, 1993.
2. B. Bilitewski, G. H. Hard, K. Marek, A. Weissbach, and H. Boeddicker, Waste Management, Berlin: Springer, 1994.
3. F. R. White, P. R. Franke, M. Hindle, and P. McDougall, Integrated Solid Waste Management: A Life Cycle Inventory, Chichester: John Wiley & Sons, 2001.
4. N. P. Cheremisinoff, Handbook of Solid Waste Management and Waste Minimization Technologies, Oxford: Elsevier Science, 2005.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://nptel.ac.in/courses/105103205
2. https://www.youtube.com/watch?v=k0ktJRoRcOA
3. https://nptel.ac.in/courses/103/107/103107125/
4. https://onlinecourses.nptel.ac.in/noc22_ce76/preview
5. https://onlinecourses.swayam2.ac.in/cec20_ge13/preview

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

UHV -1: SOCIAL CONNECT & RESPONSIBILITIES

(Effective from the Academic Year 2024-2025)

III SEMESTER

Course Code	**BHU307TK**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**16L**	Exam Hours	01

CREDITS – 1

COURSE PREREQUISITES:

- Have/Develop the critical analysis of the day today happenings.

COURSE OBJECTIVES:

This course will enable students to:

- Enable the student to do a deep drive into societal challenges being addressed by NGO(s), social enterprises & The government and build solutions to alleviate these complex social problems through immersion, design & technology.
- Provide a formal platform for students to communicate and connect to their surroundings.
- Enable to create a responsible connection with society

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies

COURSE CONTENTS

MODULE - I

Connectivity with Nature: Importance of plants**,** Plantation process, **Plant Development:** Sequence of Plant Development, Factors affecting Plant Development, Practice Problems. Activity: Self-study on selected plant's origin, its usage in daily life and its appearance in folklore and literature.	**4 Hours**

MODULE - II

Heritage walks and Regional Crafts: An overview of Heritage, Awareness on Indian Cultural Heritages, Crafts & Heritage, Protective measures for the survival of handicrafts. Activity: Self-study on selected Heritage and its Inheritance.	**4 Hours**

MODULE - III	
Organic farming and waste management: Introduction of organic farming, study on wet waste Management, Effects of organic farming on crop productivity. **Water Conservation:** Necessity of water conservation, study on water reuse, an overview on rainwater harvesting. Activity: Documentary or photo blog presenting the current practices.	**4 Hours**
MODULE - IV	
Food Practices: Comparative study of traditional food and fast food. Food-lore and indigenous materials of the region used in cooking. Cultural Significance of Meal Times, The Role of Spices and Herbs in Global Cuisines. Food as a Celebration.	**4 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	To understand the social responsibility of individual-Adaptation and Plantation of Tree	CL3
CO2	To know the heritage and holistic places - Heritage Walk and crafts corner	CL3
CO3	To understand the importance of Organic farming and waste management & Water Conservation	CL3
CO4	To understand diverse food practices, cultural significance, and food traditions across different regions	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)											Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1			1	2	1	2							
CO2	1			1	1	1	1							
CO3	1			1	2	1								
CO4	1			1	2	1								

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)		Semester End Exam (SEE) (50%)
	Continuous Internal Evaluation (CIE) (60%)	Assignment/ Activities (40%)	

	I	II	III		
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
	40%	30%	30%	100%	100%
CO1	M1			MI	MI
CO2	MII	MII		MII	MII
CO3		MIII		MIII	MIII
CO4			MIV	MIV	MIV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Case Studies	25 %	05
3	Seminar/Presentation	25 %	05
4	Peer - to - Peer Learning	25 %	05

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- Theory SEE will be conducted, with common question papers for the subject (Duration 01 hour)
- The question paper will have 50 questions. Each question is set for 02 marks.
- The student has to answer all the questions, selecting one full question from each module.

TEXT BOOKS:

1 Organic Farming for Sustainable Agriculture by **Saravanan Raj & S. Karthikeyan**, Scientific Publishers.
2 Human values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Exel books, New Delhi 2010

REFERENCE BOOKS:

1 The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
2 Human Values, A. N Tripathi, New Age Intl.Publishers,New Delhi,2004.
3 Small is Beautiful-E F Suchumacher.
4 The Story of Stuff (Book)

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://www.youtube.com/user/ccrtdelhi
2. https://www.eatrightindia.gov.in/
3. https://www.intach.org/

GENERATIVE DESIGN LAB
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BME308A1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic knowledge of parametric 3D CAD tool, preferably Fusion 360
- Basic knowledge of Engineering drawings

COURSE OBJECTIVES:

- To familiarize and enable student to learn generative design and its applications.
- To enable students, learn the CAD software for Generative design.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Construct, set up, and complete a Shape Optimization study. Promote a Shape Optimization result. Incorporate Shape Optimization result features using design workspace tools. Open the Motorcycle Triple Clamp provided dataset after uploading it.f3d. Setting up, solving, and reviewing the results of a Shape Optimization research are the objectives of this task.
2	Use Edit Model to create obstacles while maintaining geometry. Create geometry to be utilized in the Design workspace or the Generative Design workspace as preserve regions. Create a new Generative Design study that categorizes the produced geometry as preserve regions.
3	Apply a load and constraint, duplicate a load scenario, choose a material, and choose a generative design production technique. Challenge: Creating a motorcycle brake lever from scratch
4	Establish a simulation study, alter a form, create a distributed design, and examine the outcomes of the simulation. Post-process a generative design as a challenge.
5	Examine additional forms-based tools that can be used to alter the results of generative design. Use Fill, Smooth, Cylindrify, and erase. Make a Form cylinder primitive, experiment with the modification tools in the Form toolset, then extrude edges using Edit Form. Challenge: Investigate the editing features in the generating frame.f3d
6	Complete the development of a generative motorcycle swing arm.
7	Examine the topology optimization setup procedure and compare the outcomes to conventional parametric optimization techniques for a cantilevered bracket.
8	Generative design with AI in 3D modeling - Write blender code with ChatGPT and use blender software to execute.
9	Capstone Project 1 in Generative Design
10	Capstone Project 2 in Generative Design

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply generative design tools and T-Spline modeling techniques in Autodesk Fusion 360 to create and modify functional and freeform 3D components	CL 3
CO2	Apply assembly tools in Autodesk Fusion 360 to create and manage basic mechanical assemblies using joints and constraints.	CL 3
CO3	Apply generative design tools in Autodesk Fusion 360 to create optimized design solutions based on functional and manufacturing requirements.	CL 3
CO4	Apply tools in Autodesk Fusion 360 to explore, compare, and interpret generative design outcomes for selecting optimal design solutions.	CL 3
CO5	Apply advanced modeling and editing tools in Autodesk Fusion 360 to finalize detailed and manufacturable 3D designs.	CL 3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1	3		
CO2	3	2	3		2							1	3		
CO3	3	2	3		2							1	3		
CO4	3	2	3		2							1	3		
CO5	3	2	3		2							1	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and

component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Introduction to Generative Design for Manufacturing

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. https://www.autodesk.com/certification/learn/course/fusion360-generative-design-intro-expert

FUEL CONVERSION LAB
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	BME308A2	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Elements of Mechanical Engineering
- Fluid Mechanics
- Thermodynamics

COURSE OBJECTIVES:

- To train students in various oil extraction techniques and fuel property evaluation methods.
- To develop proficiency in biodiesel production from high FFA and hybrid oils using esterification and transesterification processes.
- To enable students to blend biofuels with conventional diesel and assess key fuel properties for performance and safety.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Extract oil from seeds using the boiling/heating process.
2	Extract oil from seeds using solvent extraction method.
3	Determination of Free Fatty Acid (FFA) Content.
4	Esterification of High FFA Oils using acid catalyst.
5	Alkali-Catalyzed Transesterification of Vegetable Oil.
6	Hybrid Oil Transesterification.
7	Recovery of Alcohol after Transesterification Process.
8	Preparation of blends with conventional diesel oil.
9	Determination of Density and Specific Gravity of fuels by using Hydrometer or Digital Density Meter.
10	Determination of Viscosity, Flash and Fire Point.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Perform oil extraction using both heating and solvent-based methods, and evaluate the yield efficiency.	CL 4

CO2	Analyze Free Fatty Acid (FFA) content and carry out acid esterification for high FFA oils.	CL 4
CO3	Conduct alkali-catalyzed and hybrid transesterification processes for biodiesel production.	CL 3
CO4	Prepare biodiesel-diesel blends and characterize them for density, viscosity, flash, and fire points.	CL 3
CO5	Recover and quantify alcohol post-transesterification to optimize process economy and environmental compliance.	CL 5

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		2		2	2					2			3
CO2	3	3		2		2	3					2			3
CO3	3	2	2	1	2	1	2					2			3
CO4	3	2	2	1	2	1	2					2			3
CO5	2	3	2	3	2	2	3		1	1	2	2			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.

- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Biofuel Production, Performance, and Emission Optimization, Manjunath Patel, G. C., Ajith, B. S., Shettigar, A. K., & Samuel, O. D. (2025). Springer Optimization and Its Applications.
2. Handbook of Biofuels Production: Processes and Technologies (Woodhead Publishing Series in Energy) Hardcover – Import, 25 November 2010 by Rafael Luque (Editor), James H. Clark (Editor)
3. Fuels and Combustion, Samir Sarkar, 3rd Edition, 2010, Universities Press.
4. Engineering Chemistry, Jain and Jain, 16th Edition, 2022, Dhanpat Rai Publishing.
5. A Textbook of Fuels, Lubricants, and Petrochemicals, B.K. Sharma, 5th Edition, 2019, Goel Publishing House.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. NPTEL: https://youtu.be/iHsIs9_3Ykk?si=6RMuQwd02fTIB_wt
2. NPTEL: https://youtu.be/T3WfCEBbvzM?si=S5ImZDpNq99Qk7l-

FOUNDRY TECHNOLOGY LAB
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BME308A3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basics of Engineering Materials: Properties of metals and alloys commonly used in casting.
- Manufacturing Technology: Fundamental concepts of casting processes and equipment.
- Thermodynamics and Heat Transfer: Understanding of thermal properties and their impact on solidification.
- Workshop Practices: Familiarity with handling tools and materials in a manufacturing setting.

COURSE OBJECTIVES:

- To provide hands-on experience with the processes and techniques involved in modern foundry practices.
- To understand the properties of molding materials and evaluate their suitability for different casting methods.
- To analyze and prevent defects in cast products through experimentation and process optimization.
- To apply simulation tools and advanced technologies for improving casting efficiency and product quality.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporated for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Preparation and testing of green sand for molding applications.
2	Study of permeability and moisture content in molding sand.
3	Determination of green compressive strength of molding sand.
4	Design and fabrication of a pattern for sand casting.
5	Preparation of molds for sand casting using gating systems.
6	Casting of simple components using green sand molds.
7	Observation and analysis of casting defects and their causes.
8	Use of core-making processes and testing of core properties.
9	Measurement of fluidity of molten metal using standard tests.
10	Heat treatment of cast components to improve mechanical properties.
11	Application of casting simulation software to optimize gating and riser systems.
12	Study and practice of advanced casting methods such as investment casting and die casting.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Ability to evaluate and improve the properties of molding and core-making materials.	CL3
CO2	Competence in using advanced casting technologies and simulation tools for defect prevention.	CL3
CO3	Proficiency in handling, designing, and optimizing the casting processes in industrial settings.	CL3
CO4	Skill in analyzing the quality and performance of cast products through experimentation and testing.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.

- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. R. W. Heine, C. R. Loper, and P. C. Rosenthal, Principles of Metal Casting, 2nd ed., Tata McGraw-Hill, 1999.
2. P. N. Rao, Manufacturing Technology: Foundry, Forming, and Welding, Vol. 1, 4th ed., Tata McGraw-Hill, 2013.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. **https://archive.nptel.ac.in/courses/112/107/112107215/**

DATA WRANGLING, ANALYSIS & VISUALIZATION
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	BME308A4	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic knowledge of Python as covered in AEC - Python for Scientific Computing.
- Basic knowledge of statistics, graphs and linear algebra.

COURSE OBJECTIVES:

- To become familiar in the utilisation of python data science libraries such as Pandas, Seaborn, Scipy, Numpy, Matplotlib, Plotly and special libraries such as Geopandas.
- To learn the techniques of using python libraries for data preprocessing, data analysis and data visualization.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Pandas Basics and Data Cleaning: Use Pandas library to load, clean, and preprocess data. Read various data formats, handling missing values, and basic data manipulation.
2	Data Transformation with Pandas: Explore more advanced data transformation techniques using Pandas. Perform merging, grouping, pivoting, and reshaping data for analysis.
3	Data Cleaning with Regular Expressions: Use regular expressions in Python to clean and preprocess text data effectively. Use the `re` module for pattern matching and text manipulation.
4	Exploratory Data Analysis (EDA) with Seaborn and Matplotlib: Perform exploratory data analysis using Seaborn and Matplotlib libraries. Create different types of plots and visualizations to understand data distribution and relationships.
5	Statistical Data Analysis with SciPy: Perform statistical analysis using the SciPy library. Demonstrate basic statistical tests, hypothesis testing, and summary statistics to analyze datasets.
6	Time Series Analysis with Pandas: Analyze time series data using Pandas. Use techniques for resampling, rolling statistics, and plotting time-based data.
7	Machine Learning for Data Analysis with Scikit-Learn: Explore basic machine learning techniques for data analysis using the Scikit-Learn library. Conduct classification, regression, and clustering algorithms for various datasets.
8	Data Visualization with Matplotlib: Learn the fundamentals of data visualization using the Matplotlib library. Create different types of plots and customizing visualizations.
9	Interactive Data Visualization with Plotly: Explore interactive and web-based data visualization using Plotly. Create dynamic visualizations that can be embedded in web applications.

10	Geospatial Data Visualization with Geopandas: Use geospatial data and create maps using the Geopandas library. Load geographic data, performing spatial analysis, and generating maps.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply data manipulation and preprocessing techniques using Pandas to clean and transform structured and unstructured datasets.	CL 3
CO2	Utilize regular expressions in Python to clean, extract, and manipulate text data effectively.	CL 3
CO3	Analyze complex datasets using exploratory data analysis techniques and visualizations to uncover patterns, trends, and relationships using Matplotlib and Seaborn.	CL 4
CO4	Examine time series and machine learning models to identify patterns, trends, and predictions in real-world datasets.	CL 4
CO5	Develop interactive and geospatial data visualizations using Plotly and Geopandas to effectively communicate analytical insights.	CL 4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2					2		2			
CO2	3	2	3		2					2		2			
CO3	3	2	3		2					2		2			
CO4	3	2	3		2					2		2			
CO5	3	2	3		2					2		2			
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and

component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Pandas Basics: https://pandas.pydata.org/docs/getting_started/intro_tutorials/index.html
2. Data transformation using Panadas: https://pandas.pydata.org/pandasdocs/stable/getting_started/intro_tutorials/06_calculate_statistics.html
3. Data Cleaning with Regular Expressions: https://www.datacamp.com/community/tutorials/pythonregular-expression-tutorial
4. Exploratory Data Analysis (EDA) with Seaborn and Matplotlib: https://seaborn.pydata.org/tutorial.html
5. Statistical Data Analysis with SciPy: https://docs.scipy.org/doc/scipy/reference/tutorial/stats.html
6. Time Series Analysis with Pandas: https://pandas.pydata.org/pandasdocs/stable/user_guide/timeseries.html
7. Machine Learning for Data Analysis with Scikit-Learn: https://scikit-learn.org/stable/tutorial/index.html
8. Data Visualization with Matplotlib: Learn the fundamentals of data visualization using the Matplotlib library. https://matplotlib.org/stable/tutorials/introductory/pyplot.html
9. Plotly Python Tutorial: https://plotly.com/python/
10. Geopandas Documentation: https://geopandas.org/docs/user_guide.html

APPLIED THERMODYNAMICS
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BME401G**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of Mathematics, Elements of Mechanical Engineering, and Basic Thermodynamics.

COURSE OBJECTIVES:

- To understand fundamentals of I.C. Engines, Construction and working Principle of an Engine and Compare Actual, Fuel-Air and Air standard cycle Performance.
- To understand the applications of the first and second laws of Thermodynamics to various gas processes and cycles.
- To understand the concepts related to Air conditioning to get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.
- To understand theory and performance Calculation of Positive displacement compressor.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I	
I.C. Engines: Detonation and factors affecting detonation, IC Engine fuels and Ratings, Alternate Fuels. **Air standard cycles:** Carnot, Otto, Diesel, Dual combustion cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles. Numericals on cycles.	**10 Hours**
MODULE - II	
Gas power Cycles: Brayton cycle; description and analysis. Regenerative gas turbine cycle. Intercooling and reheating in gas turbine cycles. Introduction to Jet Propulsion cycles. Numericals.	**10 Hours**
MODULE - III	
Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, open and closed feed water heaters. Reheat Rankine cycle. Characteristics of an Ideal working fluid in vapour power cycles. Numericals.	**10 Hours**
MODULE - IV	

Psychometrics and Air-conditioning Systems: Psychometric properties of air, psychometric chart, air-conditioning processes; heating, cooling, humidification and dehumidification, summer and winter air-conditioning systems, adiabatic mixing of two moist air streams, numericals. **Reciprocating Compressors:** Operation of a single stage reciprocating compressors. Work input through P-V diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, optimizing power consumption, methods of Optimum intermediate pressure, Inter-cooling, Minimum work for compression. Numericals.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the performance and efficiency of air standard cycles—Carnot, Otto, Diesel, and Dual—using P-V and T-S diagrams for comparative evaluation of thermodynamic behavior in IC engine applications.	CL4
CO2	Analyze gas turbine and jet propulsion cycles including Brayton cycle with intercooling, reheating, and regeneration, to determine their impact on work output and cycle efficiency.	CL4
CO3	Analyze vapour power cycles including ideal and actual Rankine cycles, reheat and regenerative configurations, to assess improvements in cycle performance due to pressure and temperature variations.	CL4
CO4	Analyze air-conditioning processes and reciprocating compressor performance using psychrometric principles and P-V diagrams to evaluate system behavior under different operational conditions.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Performance test and heat balance sheet on single cylinder 4-stroke diesel engine.	CO1	CL4
2.	Performance test on 4-stroke petrol engine.	CO1	CL4
3.	Performance test on 2-stroke single cylinder petrol engine.	CO1	CL4
4.	Morse test on multi cylinder petrol engine.	CO1	CL4
5.	Performance test on variable compression ratio petrol engine.	CO1	CL4
6.	Virtual – Demonstration on gas turbines and gas turbine engines.	CO2	CL4
7.	Visit to nearby steam power plant to understand the power generation	CO3	CL4
8.	Experimentation on COP of Vapor Compression Refrigeration system.	CO4	CL4
9.	Experimentation on COP of Air-Conditioning system.	CO4	CL4
10.	Experimentation on single and double stage reciprocating compressors.	CO4	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1					1	1	1		1			3
CO2	3	3	1			1		1	1	1		1			3
CO3	3	3	1			1	2	1	1	1		1			3
CO4	3	3	1				2	1	1	1		1			3

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks

1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Engineering Thermodynamics, P K Nag, Tata McGraw Hill Pub, 7th Edition, 2020.
2. Thermodynamics, Yunus A Cengel, Michael A Boles, Tata McGraw Hill, 9th Edition, 2019.
3. Applications of Thermodynamics, V.Kadambi, T.R. Seetharam, K. B. Subramanya Kumar, Wiley Indian Private Ltd, 1st Edition, 2019.
4. Applied Thermodynamics, B.K Venkanna, Swati B. Wadavadagi, PHI, New Delhi, 2010.
5. Fundamental of Classical Thermodynamics, G.J. Van Wylen and R.E. Sontang, Wiley eastern, 8th edition, 2014.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (If Any):

1. https://onlinecourses.nptel.ac.in/noc21_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_me119/preview
3. https://nptel.ac.in/courses/112105266

MACHINING SCIENCE AND JIGS & FIXTURES
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BME402G**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge on manufacturing methods, tooling and machine tools.

COURSE OBJECTIVES:

This course will enable students to:

- Utilize the subtractive machining process in manufacturing industries.
- Identify forces involved and Solve numerical problems in tool wear and tool life of machining processes.
- Understand the Non-Conventional machining processes
- Design and develop jigs & Fixtures for industrial applications

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Machining Processes and Machine tools: Need and classification of machining processes; Configuration, Specification and Classification of machine tools - Lathe, Milling Machine, Drilling Machine, Shaping Machine, Planer Machine. **Finishing and Super-Finishing Processes**: Grinding machine and its classification, Selection of grinding wheels and their conditioning methods. Lapping and Honing.	**10 Hours**

MODULE - II

Cutting tool: Orthogonal and oblique cutting Single point cutting tool nomenclature, geometry. Mechanics of Chip Formation, Types of Chips. Tool Wear and Tool failure, tool life. Effects of cutting parameters on tool life. Tool Failure Criteria, Taylor's Tool Life equation. Problems on tool life evaluation. **Types of cutting tool materials** – HSS, carbides coated carbides, ceramics etc. **Cutting fluids -** Desired properties, types and selection.	**10 Hours**

MODULE - III

INTRODUCTION TO CNC MACHINE TOOLS: Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre,	**10 Hours**

machining centre, **STRUCTURE OF CNC MACHINE TOOL**: CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guideways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion. **CNC PROGRAMMING**: Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation	

MODULE - IV

Jigs and Fixtures: Introduction: Functions and differences between jigs and fixtures, advantages and applications, Essential features of Jigs and Fixtures, materials and methods used for manufacturing jigs and fixtures. **Location**: 3-2-1 Principle of location, different types of locating elements. **Clamping**: Principles of clamping, types of clamping devices, and power clamping. Drill bushes. **Drill jigs**: Different types, exercises of designing jigs for simple components. **Fixture Design**: Turning fixtures, milling fixtures, grinding fixtures, and modular fixtures.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply knowledge to select and operate appropriate machining and finishing processes based on machine tool configurations, specifications, and work requirements.	CL3
CO2	Identify forces involved and Solve numerical problems in tool wear and tool life of machining processes.	CL3
CO3	Apply the principles of CNC technology to interpret machine tool structure and develop basic CNC part programs using G & M codes with appropriate tool compensation.	CL3
CO4	Design and develop jigs & Fixtures for industrial applications	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Simple machining (Turning, facing, taper turning) of Mild steel and Copper using High Speed Steel (HSS) tool and Tungsten carbide tipped tool.	CO1	CL3
2.	Perform thread turning operation to analyze various parameters involved in thread profiles	CO1	CL3
3.	Performing different cutting operations using Shaper machine	CO1	CL3
4.	Experiment to manufacture spur gear using simple indexing mechanism	CO1	CL3
5.	Prepare a component using a surface grinding machine.	CO1	CL3
6.	Cutting force measurement with Lathe tool dynamometers for turning operation.	CO2	CL3
7.	Cutting force measurement with Drill tool dynamometers for drilling operation.	CO2	CL3

8.	Demonstration on CNC Turning & Machining centre.	CO3	CL3
9.	Design & Develop drill jig based on drill jig design using CAD software	CO4	CL3
10.	Design Fixture for different components using a CAD Software	CO4	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	2	2	2				2			2	1	2	1
CO2	2	3	2	2	2				2			2	1	2	1
CO3	2	2	2	1	2				2			2	1	2	1
CO4	2	2	3	2	2				2			2	1	2	1

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from the first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, they will have a choice in Modules 3 and 4.

REFERENCE BOOKS:

1. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: http://nptel.ac.in/courses/112104028/.
2. U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: http://nptel.ac.in/courses/112103248/.
3. A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, https://nptel.ac.in/courses/112/105/112105126/.
4. Mikell P. Groover, (2019), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publications.
5. Rao P. N., Manufacturing Technology II, Tata McGraw Hill
6. Shaw, M C, (2014), Metal Cutting Principles, Oxford University Press.
7. McGeough, J A, (1988), Advanced Methods of Machining, Springer.
8. Boothroyd, G., and Knight, W. A., Fundamentals of Machining and Machine Tools, CRC Press.

9. Chattopadhyay, A B, (2013), Machining and Machine Tools, Wiley India.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (If Any):

KINEMATICS OF MACHINES
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BME403T**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Gears and Gear Trains from Elements of Mechanical Engineering.

COURSE OBJECTIVES:

This course will enable students to:

- To understand the concept of machines, mechanisms and related terminologies.
- To expose the students to various mechanisms and motion transmission elements used in Mechanical Engineering.
- To analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the theory of cams, gears and gear trains

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Definitions: Link, types of links, joint, types of joints kinematic pairs, Constrained motion, Kinematic chain, Mechanism and types, Degrees of freedom of planar mechanisms, Equivalent mechanisms, Grashoff's criteria and types of four bar Mechanisms, Inversions of four bar chain, Slider crank chain, Double slider crank chain and its inversions, Grashoff's chain. **Mechanisms:** Quick return motion mechanisms- Drag link mechanism, Straight line motion mechanisms, Peaucellier's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism.	**10 Hours**

MODULE - II

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Loop Closure equation, Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method. Analytical expression for the determination of velocity and acceleration of piston of a reciprocating engine. Simple Numerical Problems. Freudenstein's equation for slider crank mechanism.	**10 Hours**

MODULE - III

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Angular velocity and angular acceleration of links. **Cams:** Classification of cams, Types of followers, Cam nomenclature, Follower motions and motion analysis of SHM, Motion with uniform acceleration and deceleration, Cycloidal motion, Cam profile with offset knife-edge follower, Roller follower.	**10 Hours**

MODULE - IV

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference. **Gear Trains:** Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the concepts of links, joints, kinematic pairs, and constrained motion to demonstrate the working of planar kinematic chains and their inversions, including quick return, straight-line, and intermittent motion mechanisms."	CL3
CO2	Analyze the velocity and acceleration of planar mechanisms such as four-bar and slider crank mechanisms using analytical and complex algebra methods, including loop closure equations.	CL4
CO3	Analyze graphically the velocity and acceleration of the planar mechanisms and Develop CAM Profile using SHM, UARM and Cycloidal motions of the follower.	CL4
CO4	Inspect gear parameters such as length of path of contact, Contact ratio, Minimum number of teeth to avoid interference and examine the gear trains.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		2			2	2	2		2	3		
CO2	3	2	2					2	2	2		2	3		
CO3	3	2	2					2	2	2		2	3		
CO4	3	2	2					2	2	2		2	3		

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10

7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses– Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Mechanisms and Machines Kinematics, Dynamics and Synthesis by Michael M Stanisic, Cengage Learning, 2016
2. Theory of Machines by R S Khurmi&J.K Gupta, S Chand Publishing, 14th revised edition, 2015
3. Theory of Machines by Rattan S.S Tata, McGraw-Hill publishing company, 2014
4. Theory of Machines Kinematics and Dynamics by Sadhu Singh, Pearson Education, 3rd edition, 2019
5. Mechanism and Machine Theory by G Ambedkar, PHI 2009.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://youtu.be/yDEJxYGAoso
2. https://youtu.be/e1n-7Wz8dhg
3. https://youtu.be/N0hTFnvIE7A
4. https://youtu.be/MJeRFzs4oRU

FLUID MECHANICS

(Effective from the Academic Year 2024 - 2025)

IV SEMESTER

Course Code	**BME404T**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

Fundamental knowledge of Engineering Mathematics and Applied Physics.

COURSE OBJECTIVES:

- To possess a functional understanding of the fundamental characteristics of fluids and grasp the concept of the continuum approximation.
- To compute the forces applied by a stationary fluid on submerged surfaces and comprehend the concept of buoyant force.
- To understand the flow behavior and dynamics within flow fields in diverse engineering applications.
- To comprehend the velocity variations, energy transfers in fluid flows, and their correlation with forces and torques, as well as to appreciate the significance of designing for minimal energy loss in fluid systems.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modeling.
- To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Basics: The concept a fluid. General Properties of fluids- dimensions and units. Newton's law of Viscosity- Newtonian and Non-Newtonian fluids- Classification. Viscous flow between fixed and moving plates. Surface tension and Pressure difference across an interface due to Surface Tension. Pressure distribution in a hydrostatic fluid. Pascal's law. Application to manometry. **Fluid Statics:** Hydrostatic forces on an arbitrary plane surface. Buoyancy and stability.	**10 Hours**

MODULE - II

Fluid Kinematics: Differential formulation for fluid flow. Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems. **Laminar and Turbulent flow:** Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation. **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, applications. **(S S)**	**10 Hours**

MODULE - III

Fluid Dynamics: Momentum equation, Impact of jets- force on fixed and moving vanes, flat and curved. Numerical. Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numerical. **Loss of head due to friction in pipes**-Major and minor losses, pipe connection in series and parallel. **Compressible flows:** Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, flow through nozzles. **(S S)**	**10 Hours**
MODULE - IV	
Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aero foils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control. **Dimensional Analysis:** Dimensional analysis and similarity. Dimensional homogeneity concept. the Raleigh's method and Buckingham Pi theorem for non-dimensional analysis of a physical phenomenon. Similitude, and types of similitude. The geometric, kinematic and dynamic similarity considerations for model and prototype	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand and apply the basic principles of fluid mechanics and fluid statics for the fluid flow.	CL3
CO2	Understand and apply the principles of buoyancy, floatation, and fluid kinematics for the flow field.	CL3
CO3	Understand and apply the basic knowledge of fluid dynamics to the vanes, and pipes to predict relevant forces, velocity, and pressures.	CL3
CO4	Illustrate the concept of boundary layer in fluid flow and apply principles of dimensional analysis and similitude to form dimensionless numbers in terms of input-output variables.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2			2
CO2	3	3	2					2				2			2
CO3	3	3	3					2				2			2
CO4	3	3	3					2				2			2

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.

The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Introduction to Fluid Mechanics, Fox, R. W., Pitchard, P.J., and McDonald, A. T., (2010), 7th Edition, John Wiley & Sons Inc.
2. Fluid Mechanics: Fundamentals and Applications, Cimbala, J.M., Cengel, Y. A. (2010), McGraw-Hill
3. Fluid Mechanics, Frank M White., (2016), 8th Edition , McGraw-Hill
4. A textbook of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers

Fundamentals of Fluid Mechanics, Munson, Young, Okiishi &Hebsch, John Wiley Publications, 7th Edition

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://www.youtube.com/watch?v=gY0MwGLq9W8&list=PLyqSpQzTE6M9DKhN7z2fOpKTJWu-639_P
2. https://www.youtube.com/watch?v=5Y8Lfsreeck&list=PL7DC83C6B3312DF1E

https://www.youtube.com/watch?v=S47aSEqm_0I&list=PLgj_V-ZKxRKrxgFyOutPJpoLFBaQMOpK-

MACHINE DRAWING AND GD&T
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	BME405L	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:
- Concepts of engineering drawing.
- Usage of basic engineering drawing tools.

COURSE OBJECTIVES:
- Identify the various types of limits, tolerance and fits on machine drawings.
- Understand the concept of orthographic projections and the importance of sectional views.
- Interpret drawing details of machine components and to prepare of assembly using CAD packages.

TEACHING - LEARNING STRATEGY:
Following are some sample strategies that can be incorporate for the Course Delivery
- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

PART A

Basic review of conventional representation of details in machine drawing (Materials, machine components, dimensioning practices & principles of drawing).

Geometrical Dimensioning and Tolerances (GD&T): Introduction, terminology, basic Rules and features of GD&T. Introduction to and material conditions, maximum material condition, least material condition. types of fits with symbols and applications.

Geometrical tolerances on drawings: Form tolerances - straightness, flatness, circularity & cylindricity, Orientation tolerances - parallelism, perpendicularity & angularity, Profile tolerances - profile of a surface & profile of a line, Location tolerances - true position, concentricity, symmetry, Runout tolerances - Runout/circular runout, total runout, Standards followed in industry.

Part modelling and assembly using SolidWorks software for the following machine components and obtaining BOM, production drawings as per GD&T standards.

1. Joints: Cotter joint (socket and spigot), Knuckle joint
2. Couplings: Protected type flanged coupling, Universal coupling
3. Cross head
4. Lifting devices
5. C Clamp (Self study)
6. I. C. Engine connecting rod (Self study)
7. Crane hook (Self study)
8. Lever safety valve (Self study)

PART B

1. Modelling of sheet metal components (Exercise Problems)

2. Surface modelling (Exercise Problems)

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply appropriate GD&T symbols to machine part drawings to accurately specify design and manufacturing requirements.	CL 3
CO2	Create 3D models and assemblies of machine components using SolidWorks by interpreting 2D engineering drawings.	CL 6
CO3	Develop production drawings of machine components using GD&T standards to ensure manufacturing accuracy and quality control.	CL 6
CO4	Design sheet metal parts using SolidWorks for manufacturing and assembly applications.	CL 6
CO5	Create surface models using SolidWorks for basic design and visualization purposes.	CL 6

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2		3			2		3		3	3	3	
CO2	3	2	2		3			2		3		3	3	3	
CO3	3	2	2		3			2		3		3	3	3	
CO4	3	2	2		3			2		3		3	3	3	
CO5	3	2	2		3			2		3		3	3	3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

- CIA shall be evaluated for max marks 50. Marks obtained shall be accounted for CIA final marks, reducing it by 50%.
- CIA component should comprise of continuous evaluation of printouts as and when the topics are covered and one closed book test covering all the topics with the ratio of 50:50.

SEE QUESTION PAPER PATTERN:

- SEE shall be evaluated for 100 marks and scaled down to 50 marks.
- Different set of Question paper shall be set by the two examiners jointly for different batches.
- Evaluation shall be carried jointly by both the examiners.
- Marks distribution: PART A + PART B = 60 + 40.
- The duration of SEE is 03 hours.

REFERENCE BOOKS:

1. "Machine Drawing", K L Narayana, P Kannaiah, K Venkata Reddy, New Age International, 3rd Edition, 2006.
2. "Machine Drawing, N D Bhatt, Charotar Publishing House Pvt. Ltd.,50th Edition, 2014.
3. "WORKBOOK AND ANSWERBOOK for Geometric Dimensioning and Tolerancing", [As per ASME Y14.5-2009], James D. Meadows, 2009.
4. "Machine Drawing", K R Gopalakrishna, Subhash publications, 20th edition, 2007.
5. "Geometric Dimensioning & Tolerancing", P S Gill, S.K. Kataria & Sons, 3rd edition, 2019.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. https://www.youtube.com/@solidworks

ENGINEERING STATISTICS & COMPLEX ANALYSIS

(Effective from the Academic Year 2025 - 2026)

SEMESTER - IV

Course Code	**BME406W1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:1	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

Applied Mathematics-I, Applied Mathematics-II, Basics of Statistics and Complex Numbers

COURSE OBJECTIVES:

- To apply statistical methods like curve fitting, correlation, and regression.
- To introduce key probability distributions and stochastic processes, including Markov chains.
- To explain sampling theory and hypothesis testing with applications.
- To understand complex functions and construct analytic functions using Cauchy-Riemann equations.

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem-Based Learning
- Case Studies
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Curve Fitting : Curve fitting by the method of least squares- fitting the curves of the form and $y = ax + b,\ y = a^x b,\ y = ae^{bx}, y = ax^2 + bx + c.$ **Correlation:** Karl Pearson's coefficient of correlation, regression analysis, lines of regression, Rank Correlation.	**8 Hours**

MODULE - II

Probability Distribution Functions: Discrete and continuous random variables, probability mass functions, probability density functions, Binomial, Poisson distributions – problems. Exponential and Normal distributions-problems. Stochastic Process, Markov Chains.	**8 Hours**

MODULE - III

Sampling theory: Null hypothesis, Alternate hypothesis, Type-1 & II error, -Only Definitions. Test of significance for small samples: Student's t-distribution, Chi-square distribution as a test of goodness of fit. Test of significance for large samples**:** Test of hypothesis for proportions and means.	**12 Hours**

MODULE - IV

Calculus of Complex functions: Review of a function of a complex variable, limits, continuity, differentiability. **Construction of analytic functions:** Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of analytic functions. Milne-Thompson Method, Harmonic Functions, Application of analytic functions.	**12 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply curve fitting, statistical correlation methods and regression analysis to solve mathematical and real-world problems.	CL3
CO2	Make use of probability distributions and Markov processes to analyze uncertainties and reliability in engineering systems.	CL3
CO3	Apply hypothesis testing techniques using t-student's test, chi-square test, and large sample tests to analyze data and validate engineering decisions.	CL3
CO4	Demonstrate the ability to analyze, differentiate, and construct complex analytic functions.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)											Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	1		2	1					1	2	1	1
CO2	3	3	1		2	1					1	2	1	2
CO3	3	2	1		2	2					1	1	2	1
CO4	3	3	1		1	1					1	1	1	1

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignment	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				**Semester End Exam (SEE) (50%)**
Continuous Internal Evaluation (CIE) (60%)			**Assignment (40%)**	
I	**II**	**III**		
Syllabus Coverage			**Syllabus Coverage**	**Syllabus Coverage**
30%	**30%**	**40%**	**100%**	**100%**
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

1. The question paper will have two parts, A and B.
2. The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
3. In Part B, Question 2 and 3 will be compulsory from the first and second module.
4. In Part B, the Question 4 and 5 will be from Module 3 and Question 6 and 7 from Module 4, with choice in respective modules.
5. The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, they will have a choice in Modules 3 and 4.

REFERENCE BOOKS:

1. N.P Bali & Dr. Manish Goyal: " Engineering Mathematics" 9th Edition, Laxmi Publications.
2. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
3. C Ray Wylie, Louis C Barrett: "Advanced Engineering Mathematics", 6th Edition,
4. Dr. K. Chandrashekar: " Complex analysis, Probability and Statistical Methods" Sudha Publications,2021

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. http://www.bookstreet.in.
5. VTU e-Shikshana Program.
6. https://www.youtube.com/watch?v=8Kg21jBCm-k
7. https://www.youtube.com/watch?v=Wa6kaCwyYRk

METAL JOINING PROCESSES

(Effective from the Academic Year 2024 - 2025)

IV SEMESTER

Course Code	**BME406W2**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basics of Engineering Materials: Understanding of material types, properties (mechanical, thermal, and electrical), and basic material science concepts.
- Engineering Mechanics: Knowledge of forces, stress, strain, and deformation in materials.

COURSE OBJECTIVES:

- To explain the principles, equipment, process variables, and applications of radiant energy welding methods such as Electron Beam Welding (EBW) and Laser Beam Welding.
- To describe the theoretical concepts, parameters, and methods of solid-state welding processes such as diffusion welding and cold pressure welding, along with their applications and limitations.
- To analyse the working principles, process characteristics, and joint design considerations in high-energy processes like explosive welding, friction welding, and friction stir welding.
- To examine the principles, equipment, types, and applications of ultrasonic welding and brazing techniques, including various brazing methods and their industrial significance.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I	
Radiant energy welding: Electron Beam Welding (EBW) - principle and theory- equipment and systems- process characteristics and variables- weld joint design- applications- EBW process variants. **Laser Beam Welding**-principle and theory-operation-types of lasers-process variables and characteristics-applications.	**10 Hours**
MODULE - II	
Diffusion welding-principle and theory-methods- welding parameters-advantages and limitations- applications. Cold pressure welding-process, equipment and set-up-applications. **Adhesive Bonding**- principle and theory-types of adhesives-joint design-bonding methods applications.	**10 Hours**
MODULE - III	
Explosive welding-principle and theory-process variables-equipment-joint design-advantages and limitations-applications. **Friction welding**-principle and theory-process variables advantages and limitations-applications. **Friction stir welding**- metal flow phenomena-tools process variables – applications.	**10 Hours**
MODULE - IV	
Ultrasonic welding-principle and theory-process variables and equipment-types of ultrasonic welds- advantages and limitations-applications. **Brazing**- principle- brazing processes-torch brazing- furnace brazing- vacuum brazing-induction brazing-advantages and limitations applications.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	**Course Outcome Description**	**Bloom's Taxonomy Level**

CO1	Demonstrate the application of Electron Beam Welding (EBW) and Laser Beam Welding by selecting appropriate process parameters and equipment for specific industrial joining tasks.	CL3
CO2	Implement solid-state welding methods such as diffusion welding, cold pressure welding, and adhesive bonding by choosing suitable processes and parameters for different material combinations.	CL3
CO3	Use explosive welding, friction welding, and friction stir welding techniques to evaluate metal joining feasibility and design efficient weld joints.	CL3
CO4	Illustrate the selection and operation of ultrasonic welding and brazing processes for manufacturing applications involving dissimilar materials and complex assemblies.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

- Welding Processing and Technology 3rd Edition, Khanna Publishers, 2003.
- ASM Metals Handbook "Welding and Brazing", Vol.6, ASM, Ohio, 1988.
- P. N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, Vol. 2, 4th ed., Tata McGraw-Hill, 2013.
- Parmar R.S., "Welding Engineering and Technology" Khanna Publishers, Delhi, 1997.
- Rossi, B.E., Welding Engineering, Mc Graw-Hill, 1954.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://nptel.ac.in/courses/113106087
2. https://www.youtube.com/watch?v=TpvmJBeGUrg&list=PLyqSpQzTE6M-KwjFQByBvRx464XpCgOEC&index=2

ADDITIVE MANUFACTURING
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	BME406W3	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge of Manufacturing Processes.
- Fundamentals of Engineering Materials and their Properties.
- Introduction to CAD and 3D Modeling Techniques.

COURSE OBJECTIVES:

- To introduce the fundamentals and classification of additive manufacturing processes.
- To understand material behavior, process parameters, and software tools used in AM.
- To explore real-world applications and evaluate suitable AM technologies for various industries.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereolithography or 3dprinting, rapid proto typing, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology. **Development of Additive Manufacturing Technology:** Introduction, computers, computer-aided sign technology, other associated technologies, the use of layers, classification of AM processes, metals systems, hybrid systems, milestones in AM development. **Additive Manufacturing Process chain:** Introduction, the eight steps in additive manufacture, variations from one AM machine to another ,metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.	**10 Hours**

MODULE - II

Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes. **Extrusion-based systems:** Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.	**10 Hours**

MODULE - III

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modeling, material modification methods, three-dimensional printing, advantages of binder printing **Sheet Lamination Processes:**	**10 Hours**

Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. **Beam Deposition Processes:** introduction, general beam deposition process, description material delivery, BD systems , process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks.	
MODULE - IV	
Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control. **Software issues for Additive Manufacturing:** Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation. **AM Applications:** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Remanufacturing. Application: Examples for Aerospace, defense, automobile, Bio-medical and general engineering industries. **Direct digital manufacturing:** Align Technology, Siemens and phonak, DDM drivers, manufacturing vs. prototyping, life-cycle costing, future of direct digital manufacturing.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the fundamental principles, process chains, and associated technologies of Additive Manufacturing (AM) to analyze the workflow, differentiate it from traditional manufacturing processes, and identify suitable applications in product development.	CL3
CO2	Apply the working principles and process parameters of Powder Bed Fusion and Extrusion-Based Additive Manufacturing systems to evaluate material compatibility, analyze process limitations, and identify suitable applications in engineering and biomedical domains.	CL3
CO3	Apply the principles and process characteristics of Printing, Sheet Lamination, and Beam Deposition methods to examine material behavior, assess process capabilities and limitations, and determine suitable applications based on structure–property relationships.	CL3
CO4	Apply suitable additive manufacturing process selection methods, software tools, and application-specific strategies to optimize product development in diverse sectors such as aerospace, biomedical, automotive, and general engineering.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Program meSpecific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	2						2		2			2
CO2	2	2	2	2					2			2			2
CO3	2	2	2	2								2			2
CO4	2	2	2	2								2			2

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				**Semester End Exam (SEE) (50%)**
Continuous Internal Evaluation (CIE) (60%)			**Assignment/ Activities (40%)**	
I	**II**	**III**		
Syllabus Coverage			**Syllabus Coverage**	**Syllabus Coverage**
40%	**30%**	**30%**	**100%**	**100%**
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker Springer, 2nd Edition (2015)
2. Rapid Prototyping: Principles and Applications, Rafiq Noorani Publisher**:** Wiley Edition: 1st Edition (2006)

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. http://www.digimat.in/nptel/courses/video/112103306/L16.html
2. https://www.youtube.com/watch?v=kQI3UHRxy1U

MICRO ELECTRO MECHANICAL SYSTEMS
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BME406W4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Engineering Physics, Electronics & Electrical Engineering and Engineering Mechanics.

COURSE OBJECTIVES:

- To introduce the fundamentals of MEMS technology and micromachining processes.
- To develop understanding of multi-domain system modelling principles for MEMS devices.
- To familiarize students with the concepts of mechanical micro-sensors and actuators.
- To provide knowledge of optical MEMS (MOEMS) devices and their working principles.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

MEMS: Introduction, Production Engineering, Precision Engineering and Ultra-Precision Engineering, Integrated circuits, Micro Electro Mechanical Systems. **Micromachining:** Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA.	**10 Hours**

MODULE - II

System Modelling: Introduction, Need for Modelling, System types, Basic Modelling Elements in Mechanical System, Basic Modelling Elements in Electrical Systems, Basic Modelling Elements in Fluid Systems and Thermal Systems.	**10 Hours**

MODULE - III

Mechanical Sensors and Actuators: Introduction, Principles of Sensing and Actuation, Beam and Cantilever, Micro Plates, Capacitive Effects, Piezo Electric Material as Sensing and Actuating Elements.	**10 Hours**

MODULE - IV

Micro-Opto-Electro Mechanical Systems: Introduction, Fundamental Principles of MOEMS Technology, Review on Properties of Light, Light Modulators, Micro mirrors, Digital Micro mirror Device.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the fundamentals of MEMS fabrication technologies such as photolithography, etching, surface and bulk micromachining, wafer bonding, and LIGA processes.	CL2
CO2	Describe different system modelling requirements and summarize the basic modelling elements used in mechanical, electrical, fluid, and thermal domains.	CL2

CO3	Illustrate the working principles of common mechanical micro-sensors and actuators such as beams, cantilevers, micro-plates, and piezoelectric devices.	CL2
CO4	Discuss the operating concepts and optical principles behind MOEMS components including light modulators, micromirrors, and DMD (Digital Micromirror Device) technology.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2	2		
CO2	3	3	2					2				2	2		
CO3	3	3	3					2				2	2		
CO4	3	3	3					2				2	2		

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40 %	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15

11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. MEMS - Nitaigour Premchand Mahalik, TMH 2007.
2. Micro and Smart Systems: G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, Wiley India 2010.
3. Design and Development Methodogies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://www.nptelprep.in/courses/117105082/materials

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

UHV -2: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT
(Effective from the Academic Year 2024-2025)
IV SEMESTER

Course Code	**BHU407TK**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**16L**	Exam Hours	01

CREDITS – 1

COURSE PREREQUISITES:

- Have/Develop the critical analysis of the day today happenings.

COURSE OBJECTIVES:

This course will enable students to:

1. To make the students to understand, the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight possible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

TEACHING - LEARNING STRATEGY:

These are some sample strategies, which course faculty members can incorporate in the Teaching Learning Process:

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies

COURSE CONTENTS

The course is mainly activity-based that will offer a set of activities for the student that enables them to connect with fellow human beings, nature, society, and the world at large. The course will engage studentsinr interactive sessions, open mic, reading groups, storytelling sessions, and semester-long activities conducted by faculty mentors. In the following a set of activities planned for the course have been listed:

MODULE - I

Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education). Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to fulfill the Basic Human Aspirations.	**3 Hours**
MODULE - II	
Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Program to ensure self-regulation and Health.	**4 Hours**
MODULE - III	
Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order. **Harmony in the Nature/Existence**: Understanding Harmony in the Nature, Inter-connectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.	**5 Hours**
MODULE - IV	
Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.	**4 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand value education to develop basic human aspirations through a holistic approach	CL3
CO2	Relate to the needs of self and body to establish co-existence leading to harmony in the human being.	CL3
CO3	Recognize the importance of trust and respect to promote harmony in the family and society. And realize the existence as coexistence to establish harmony through mutual fulfillment among four orders of nature.	CL3
CO4	Recognize the needs for a holistic understanding of human values to develop ethical and professional conduct.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)	Programme Specific

												Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1	2				2	3						2	
CO2	2	3				3	2						2	
CO3	1	2				3	3	2	2				2	
CO4	2	2				2	3	2	2	2			2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

CO - ASSESSMENT MAPPING

Course Outcomes	Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
	Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
	I	II	III		
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
	40%	30%	30%	100%	100%
CO1	MI			**MI**	**MI**
CO2	MII	MII		**MII**	**MII**
CO3		MIII		**MIII**	**MIII**
CO4			MIV	**MIV**	**MIV**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Case Studies	25 %	05
3	Seminar/Presentation	25 %	05
4	Peer - to - Peer Learning	25 %	05

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

Theory SEE will be conducted, with common question papers for the subject (**duration 01 hours)**

1. The question paper will have 50 questions. Each question is set for 02 marks.
2. The students have to answer all the questions, selecting one full question from each module

TEXT BOOKS:

1. The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
2. The Teacher's Manual Teachers" Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

REFERENCE BOOKS:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Gandhi - Romain Rolland (English)

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://www.aicteindia.org/sites/default/files/Vol.%20II%20%20AICTE%20UG%20%20Curriculum.
2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
3. https://fdp-si.aicte-india.org/8dayUHV_download.php
4. https://www.youtube.com/watch?v=8ovkLRYXIjE

PROTOTYPE FABRICATION LAB

(Effective from the Academic Year 2024 - 2025)

IV SEMESTER

Course Code	**BME408A1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

COURSE OBJECTIVES:

- **To provide practical knowledge of various metal joining techniques including welding, brazing, and soldering.**
- **To understand and apply destructive and non-destructive testing methods for evaluating joint quality.**
- **To develop hands-on skills in handling metal joining equipment and safety procedures.**
- **To correlate the mechanical properties of joints with the process parameters and material characteristics**

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Practice on flat surface filing – achieving dimensional accuracy.
2	Angular and step filing to produce a symmetric profile.
3	Cutting, bending, and forming a sheet metal tray with corner joints.
4	Fabrication of a funnel using sheet metal layout, rolling, and seaming techniques.
5	Practice on bead formation using arc welding (flat position).
6	Butt and lap joint formation using arc welding.
7	Basic soldering joints on a copper pipe assembly.
8	Soldering of electronic components on a PCB prototype.
9	Brazing of dissimilar metals (e.g., copper to steel).
10	Brazing practice on a T-joint metal structure.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the purpose and procedure of basic metal filing and hand-tool operations.	CL 2

CO2	Describe the process and techniques used in sheet metal fabrication.	CL 2
CO3	Discuss the types, methods, and safety aspects of welding operations.	CL 2
CO4	Summarize the procedure and materials required for effective soldering.	CL 2
CO5	Explain the principles and applications of brazing in prototype fabrication	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2					2		1		3	
CO2	3	2	3		2					2		1		3	
CO3	3	2	3		2					2		1		3	
CO4	3	2	3		2					2		1		3	
CO5	3	2	3		2					2		1		3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

- Workshop Technology –S.K. Hajra Choudhury, A.K. Hajra Choudhury Publisher: Media Promoters & Publishers Pvt. Ltd.

- Elements of Workshop Technology – Vol. 1 & 2 S.K. and H.K. Hajra Choudhury Publisher: Media Promoters & Publishers Pvt. Ltd.
- Welding and Welding Technology RichardL. Little Publisher: McGraw Hill Education
- Sheet Metal Technology David J. Gingery Publisher: Lindsay Publications.
- Modern Welding Author: Andrew D. Althouse, Carl H. Turnquist, William A. Bowditch Goodheart-Willcox

FUEL TESTING LAB

(Effective from the Academic Year 2024 - 2025)

IV SEMESTER

Course Code	**BME408A2**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Elements of Mechanical Engineering
- Fluid Mechanics
- Thermodynamics

COURSE OBJECTIVES:

- Gain hands-on experience in using standard laboratory instruments such as Redwood, Saybolt, Torsion Viscometers, Bomb and Junkers Calorimeters, Hydrometers, and advanced devices like Gas Chromatographs and Mass Spectrometers.
- Learn to assess key performance parameters such as viscosity, calorific value, and hydrocarbon composition to determine the quality and suitability of fuels and lubricants for various applications.
- Understand the importance of flash and fire point measurements for fuel handling, storage, and safety, and ensure adherence to industrial and environmental standards.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Determination of viscosity of lubricating oil using Redwood Viscometer.
2	Determination of viscosity of lubricating oil using Saybolt Viscometer.
3	Determination of viscosity of lubricating oil using Torsion Viscometer.
4	Determination of Calorific Value of Solid/Liquid fuels by using Bomb Calorimeter.
5	Determination of Calorific Value of gaseous fuel by using Junkers Gas Calorimeter.
6	Determination of Flash and Fire Point of lubricating oil by using Cleveland Open Cup Apparatus.
7	Determination of Flash and Fire Point of lubricating oil by using Pensky-Martens Closed Cup Apparatus.
8	Determination of Density and Specific Gravity of fuels by using Hydrometer or Digital Density Meter.
9	Determination of hydrocarbon composition in fuels using Gas Chromatography.
10	Demonstration on molecular analysis of fuels using Mass Spectrometer.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level

CO1	Analyze the physical and chemical properties of lubricating oils—such as viscosity, density, flash point, and fire point—using standard laboratory equipment and testing protocols.	CL 4
CO2	Analyze the calorific values of solid, liquid, and gaseous fuels using instruments like the Bomb Calorimeter and Junkers Gas Calorimeter to assess their energy content and efficiency.	CL 4
CO3	Analyze fuel composition and molecular characteristics using advanced analytical techniques such as gas chromatography and mass spectrometry.	CL 4
CO4	Analyze the safety parameters of fuels and lubricants by interpreting flash and fire point data to ensure compliance with safety standards for handling and storage.	CL 4
CO5	Analyze the influence of fuel and lubricant properties on engine performance, energy efficiency, and environmental impact to support decision-making in real-world engineering applications.	CL 4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1	1		1	1	1	1	1		1			3
CO2	3	2	1	1		1	1	1	1	1		1			3
CO3	3	3	1	1		1	1	1	1	1		1			3
CO4	3	3	1	1		1	1	1	1	1		1			3
CO5	3	3	1	1		1	1	1	1	1		1			3

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.

- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Fuels and Combustion, Samir Sarkar, 3rd Edition, 2010, Universities Press.
2. Engineering Chemistry, Jain and Jain, 17th Edition, 2023, Dhanpat Rai Publishing.
3. A Textbook of Fuels, Lubricants, and Petrochemicals, B.K. Sharma, 6th Edition, 2022, Goel Publishing House.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. https://archive.nptel.ac.in/courses/112/106/112106299/
2. https://onlinecourses.nptel.ac.in/noc23_ch64/preview

ROBOT PROGRAMMING LABORATORY
IV SEMESTER

Course Code	**BME408A3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of RAPID Programming**.**

COURSE OBJECTIVES:

- Describe the functionalities and operational features of the DOBOT Magician along with the usage of DOBOT Studio software.
- Explain the structure, syntax, and application of RAPID programming in industrial robotics.
- Interpret the hardware configuration, motion capabilities, and applications of the ABB IRB 1600 robot.
- Discuss the features, configuration, and industrial applications of the COGNEX vision system.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

Sl No	LIST OF EXPERIMENTS
1	Experiment on pick and place operation using DOBOT Magician (mini robot) Using Suction Cup and B) Using Pneumatic Gripper
2	Experiment to perform different operations using DOBOT magician(mini robot) a) Sorting Operation b) Stacking Operation. c) Palletising Operation.
3	Experiment to Write and Draw with pen tool using DOBOT Magician (mini robot)
4	Demonstration of 3D Printing an object using DOBOT magician (mini robot)
5	Software simulation in Robot Studio Software: Introduction to Robot Studio, Programming concepts, Libraries, geometries, and CAD files.
6	Introduction to RAPID programming: Basics of RAPID programming, Loops, Rules and recommendations for RAPID syntax. RAPID robot functionality: Instructions, I/O signals, RAPID Programming Structure:
7	Simulation to perform pick and place operation of an object in Robot Studio software.
8	Simulation to perform conveyor tracking and palletizing operation in Robot Studio Software
9	Simulation to perform sorting operation of an object in Robot Studio Software
10	Introduction to COGNEX Camera: basics of COGNEX camera, introduction to camera programming using insight explorer software.
11	Demonstration of ABB IRB 1600 robot: Pick and place operation using two jaw gripper, three jaw gripper and suction cup. Welding Operation.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze various robotic operations using the DOBOT Magician to understand its control and automation capabilities.	CL4
CO2	Comprehend the fundamental programming concepts applied in robotic systems.	CL3
CO3	Examine the structure and logic of RAPID programming used in ABB robots.	CL4
CO4	Evaluate object manipulation operations in CoppeliaSim software.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	3		2							1	2	
CO2	3	2	3		2							1	2	
CO3	3	2	3		2							1	2	
CO4	3	2	3		2							1	2	
CO5	3	2	3		2							1	2	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. https://www.youtube.com/watch?v=WcArOQuJRDI

MACHINE LEARNING LAB
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BME408A4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of PUC Mathematics and Python
- Must have completed the previous AEC course "Data wrangling, Analysis and Visualization"
- Preparatory knowledge of PyTorch, Scikit and Tensorflow.

COURSE OBJECTIVES:

- Understand and implement the concepts of Artificial Intelligence and Machine Learning.
- Write basic AI/ML programs using Tensorflow.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Linear Regression with Scikit-Learn: Implement linear regression on a simple dataset (like Boston Housing) using Scikit-Learn. Focus on data preprocessing, model fitting, and evaluation of the model.
2	Image Classification with TensorFlow: Use TensorFlow to build a convolutional neural network (CNN) for classifying images from a dataset like CIFAR-10. Explore different architectures and hyperparameters.
3	PyTorch Basics: Create a simple neural network in PyTorch. Learn to define a model, loss function, and optimizer. Train the model on a basic dataset like MNIST.
4	K-Means Clustering with Scikit-Learn: Implement K-means clustering on a dataset to understand unsupervised learning. Analyze the results and visualize the clusters.
5	Text Classification with TensorFlow: Use TensorFlow to build a recurrent neural network (RNN) for classifying text data, such as movie reviews. Explore word embeddings and LSTM/GRU layers.
6	Transfer Learning in PyTorch: Utilize a pre-trained model (like ResNet) in PyTorch for a classification task on a new dataset. Learn about fine-tuning and feature extraction approaches.
7	Decision Trees with Scikit-Learn: Build and visualize decision trees for classification or regression tasks. Understand tree parameters and how to prevent overfitting.
8	Autoencoders with TensorFlow: Create an autoencoder for dimensionality reduction or denoising on image datasets. Explore the architecture of autoencoders and their applications.
9	PyTorch Custom Dataset and DataLoader: Learn to create a custom dataset class in PyTorch. Implement a DataLoader for efficient data handling and batching during training.

10	Hyperparameter Tuning with Scikit-Learn: Use Scikit-Learn's Grid Search CV or Randomized Search CV to perform hyperparameter tuning on a machine learning model. Analyze the impact of different hyperparameters on model performance.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Build, train, and deploy various machine learning models efficiently utilizing major machine learning frameworks such as TensorFlow, PyTorch, and Scikit-Learn.	CL 3
CO2	Apply core machine learning algorithms, including supervised and unsupervised learning methods, enabling them to choose and apply the appropriate algorithm for different types of data and problems.	CL 3
CO3	Apply essential skills in data preprocessing, manipulation, and visualization, learning to effectively prepare data for machine learning models using tools like NumPy, pandas, and matplotlib.	CL 3
CO4	Evaluate complex problems in areas such as image and text analysis using comprehensive knowledge in deep learning, including the construction and training of neural networks.	CL 3
CO5	Evaluate the performance of machine learning models using various metrics and techniques, gaining expertise in tuning models for improved accuracy and efficiency, preparing them for real-world machine learning challenges.	CL 3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3		3			2	2	1		2	1	2	2
CO2	3	3	3		3			2	2	1		2	1	2	2
CO3	3	3	3		3			2	2	1		2	1	2	2
CO4	3	3	3		3			2	2	1		2	1	2	2
CO5	3	3	3		3			2	2	1		2	1	2	2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin: 3rd Edition, Pearson.
2. Computer Algorithms/C++, Ellis Horowitz, Satraj Sahni and Rajasekaran, 2nd Edition, Universities Press.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. https://developers.google.com/machine-learning/crash-course
2. https://developers.google.com/machine-learning/practica/image-classification
3. https://developers.google.com/machine-learning/intro-to-ml
4. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
5. "Deep Learning with Python" by François Chollet
6. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
7. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
8. "PyTorch Deep Learning Hands-On" by Sherin Thomas and Sudhanshu Passi
9. "Learning TensorFlow: A Guide to Building Deep Learning Systems" by Tom Hope, Yehezkel S. Resheff, and Itay Lieder

BIOLOGY FOR ENGINEERS

(Effective from the Academic Year 2024-2025)

IV SEMESTER

Course Code	**BBS409TZ**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	28L	Exam Hours	03

CREDITS – 2

COURSE PREREQUISITES:

- Basic Concepts of Biology

COURSE OBJECTIVES:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To enable the students with an understanding of bio design principles to create novel devices and structures.
- To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
- To motivate the students to develop interdisciplinary vision of biological engineering

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities.
- Students' seminars (in solo or group) /oral presentations.
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents
- Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on
- sessions, reflective and questioning /inquiry-based teaching

COURSE CONTENTS

MODULE -I

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE) — **7 Hours**

Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).
Self Study:The cell: the basic unit of life, Biomolecules, vitamins and hormones.

MODULE - II

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE): — **7 Hours**

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs), Bio fluid mechanics: Modeling of flow in blood vessels, blood flow theory.

MODULE -III

HUMAN ORGAN SYSTEMS AND BIO DESIGNS (QUALITATIVE): — **7 Hours**

Brain as a CPU system (signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (optical corrections, lens materials, bionic eye). Heart as a pump system (electrical signaling - ECG monitoring and heart related issues, design of stents, pace makers, defibrillators). Lungs as purification system (gas exchange mechanisms, spirometry, Ventilators,). Kidney

as a filtration system (mechanism of filtration, dialysis systems).	
MODULE -IV	
TRENDS IN BIOENGINEERING (QUALITATIVE): Muscular and Skeletal Systems as scaffolds (bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self-healing Bio concrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).	**7 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the role of biomolecules in engineering applications	CL2
CO2	Identify bioinspired principles from nature to develop innovative engineering solutions	CL2
CO3	Explain the analogy between human organ systems and engineered systems.	CL2
CO4	Outline significant technological trends shaping modern bioengineering	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11		1	2
CO1	3	2	1	1	2	2	1				1			
CO2	2	2	3	2	2	2	2	2	1	1	2			
CO3	2	2	2	1	2	2			2		2			
CO4	2	1	1	2	1	1	1				3			

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
M1			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Case Studies	25 %	05
3	Seminar/Presentation	25 %	05
4	Peer - to - Peer Learning	25 %	05

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

1. The question paper will have 7 full questions from 4 modules which is divides into Part A & Part B
2. Question number 1 of part A will have any number of sub question covering all the 4 modules totaling to 20 marks.
3. Part A - Question number 2 & 3 will be from module 1 & 2 respectively with a maximum of 3 sub questions and without choice. Each question will carry a maximum of 20 marks.
4. Part B - Question number 4 & 5 will be from module 3 with the maximum of 3 sub questions, the students has to answer any one full question. Each question will carry a maximum of 20 marks.
5. Part B - Question number 6 & 7 will be from module 4 with a maximum of 3 sub questions, the students has to answer any one full question. Each question will carry a maximum of 20 marks.

TEXT BOOKS:

1. Biology for Engineers, Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
2. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022 Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
3. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
4. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
5. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C Udayashankar Lambert Academic Publishing, 2019
6. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

REFERENCE BOOKS:

1. Biomaterials Science and Tissue Engineering: Principles and Methods, by Bikramjit Basu, Cambridge IISc Series.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://www.youtube.com/watch?v=96-u9s6D16k
2. https://www.youtube.com/watch?v=4_emccqgYMs
3. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
4. https://onlinecourses.nptel.ac.in/noc22_cs29/preview

FINITE ELEMENT METHOD
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BME501G**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of Mathematics, Mechanics of Materials.

COURSE OBJECTIVES:

- To learn the basic principles of finite element analysis procedure.
- To formulate and solve for displacement, stress and strain on bar, truss, beams and torsion of shaft using Finite Element Analysis approach.
- To Formulate and solve the problems on heat transfer and dynamic consideration using Finite Element Analysis approach.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Finite Element Method: General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method. Potential energy method, Displacement method of finite element formulation. Convergence criteria, Discretization process. Rayleigh Ritz method. **Types of elements:** 1D, 2D and 3D, Node numbering, Location of nodes. Strain- displacement relations, Stress-strain relations, Plain stress and Plain strain conditions.	**10 Hours**

MODULE - II

Interpolation models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements. **Stiffness method:** Introduction, Linear interpolation polynomials in terms of Global, natural and local coordinate's for 1D, 2D elements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 3 8), 2D iso-parametric element.	**10 Hours**

MODULE - III

Bars: One-Dimensional Elements-Analysis of Bars and Solution for displacement, stress and strain in 1D straight bar, stepped bars and tapered bars using elimination approach and penalty approach.	**10 Hours**

Trusses: Analysis of trusses and Solution for displacement, stress and strain in trusses. **Beams:** Boundary conditions, Load vector, Hermite shape functions , Beam stiffness matrix based on Euler Bernoulli beam theory, Numerical problems on simply supported, fixed straight and cantilever beams, cantilever beams with concentrated and uniformly distributed load.	

MODULE - IV

Shafts: Analysis of shafts, determination of shear stresses and twists in circular shafts. **Heat Transfer:** Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins. Multi Conduction Equation. **Dynamic Considerations:** Formulation for point mass and distributed masses, Consistent element mass matrix of one-dimensional bar element, truss element, triangular element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the fundamental steps of the finite element method to engineering problems by using displacement and potential energy formulations.	CL3
CO2	Analyze the stiffness formulation of 1D, 2D, and 3D elements using interpolation functions in global, natural, and local coordinate systems	CL4
CO3	Analyze one-dimensional structural elements such as bars, trusses, and beams to determine displacements, stresses, and strains using the elimination and penalty approaches	CL4
CO4	Analyze the finite element formulation of Shafts, Heat transfer and dynamic consideration.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Stress analysis of a rectangular plate with a circular hole.	CO2	CL4
2.	Stress analysis of Bars with constant cross section area.	CO3	CL4
3.	Stress analysis of Bars with tapered cross section area.	CO3	CL4
4.	Stress analysis of a stepped Bar.	CO3	CL4
5.	Stress analysis of Truss.	CO3	CL4
6.	SFD and BMD of cantilever Beam with point loads.	CO3	CL4
7.	SFD and BMD of cantilever Beam with point loads and UDL.	CO3	CL4
8.	SFD and BMD of simply supported Beam with point load, UDL and UVL	CO3	CL4
9.	Heat transfer analysis with conduction and convection boundary condition.	CO4	CL4
10.	Dynamic Analysis to find Natural frequency of beam with both ends fixed.	CO4	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2					2	2	2		2	3		
CO2	3	2	2		2			2	2	2		2	3		
CO3	3	2	2		2			2	2	2		2	3		
CO4	3	2	2		2			2	2	2		2	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
4. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
5. Rao S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
6. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
7. J.N.Reddy, —Finite Element Method"- McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
8. Cook R. D., et al. —Conceptsand Application of Finite Elements Analysis"- 4 th Edition, Wiley & Sons, 2003.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. Finite Element Method https://onlinecourses.nptel.ac.in/noc22_me43/preview
2. Basics of Finite Element Analysis-I https://archive.nptel.ac.in/courses/112/104/112104193/
3. Basics of Finite Element Analysis -II https://nptel.ac.in/courses/112104205

DYNAMICS OF MACHINES

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code:	**BME502G**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Kinematics of Machines.

COURSE OBJECTIVES:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the principles in mechanisms used for speed control and stability control.
  To compute the natural and damped frequencies of free 1-DOF mechanical systems.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Static force analysis: Static equilibrium, Equilibrium condition of a body subjected to two force, three force, two force and a couple. Analysis of four bar mechanism. **Dynamic force analysis:** D-Alembert's principle, analysis of four bar and slider crank mechanism.	**10 Hours**

MODULE - II

Balancing of Rotating Masses: Static and Dynamic Balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. **Balancing of Reciprocating Masses:** Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces), V-type engine, Radial engine – direct and reverse crank method.	**10 Hours**

MODULE - III

Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. **Gyroscope:** Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic Couple on plane disc, ship, aero plane **Introduction & Undamped free Vibrations (Single Degree of Freedom):** Types of vibrations, Definitions, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM (Addition of SHM).	**10 Hours**

MODULE - IV

Damped free Vibrations (Single Degree of Freedom): Types of damping, Analysis with viscous damping - Derivations for over, critical and under damped systems, Logarithmic decrement and numerical problems. **Forced vibrations:** Damped forced vibration of spring mass system, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Numerical problems. Critical speed.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the forces and couples for Static and dynamic conditions for four bar and slider crank mechanism.	CL4
CO2	Examine Static and dynamic balancing of forces of rotating and reciprocating masses.	CL4
CO3	Inspect the forces, sensitivity, effort and power of Porter and Hartnel governor and examine the gyroscopic effect on Ship and Aeroplane.	CL4
CO4	Analyze the natural frequency of single degree of freedom Undamped free vibrations.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Virtual Lab on Position analysis of Grashof and Non Grashof four bar Mechanism.	CO1	CL4
2.	Virtual Lab on Position and Velocity analysis of Slider Crank Mechanism.	CO1	CL4
3.	Balancing of rotating masses.	CO2	CL4
4.	Determination of equilibrium speed, sensitiveness, power and effort of Porter governor.	CO3	CL4
5.	Demonstration on the working of Gyroscope.	CO3	CL4
6.	Determination of natural frequency in a undamped single degree of freedom vibrating systems (longitudinal).	CO3	CL4
7.	Determination of natural frequency in a undamped single degree of freedom vibrating systems (Torsional).	CO4	CL4
8.	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal).	CO4	CL4
9.	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (Torsional).	CO4	CL4
10.	Determination of critical speed of a rotating shaft.	CO4	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3						2	2		2	3		
CO2	3	3	3	1					2	2		2	3		
CO3	3	3	3	1					2	2		2	3		
CO4	3	3	3	1								2	3		

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15

	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Theory of Machines by S S Rattan.
2. Mechanisms and Machines-Kinematics, Dynamics and Synthesis by Michael M Stanisic.
3. Dynamics of Machines by J B K Das.
4. Theory of Machines: Kinematics and Dynamics by Sadhu Singh.

Mechanism and Machine Theory by G. Ambekar.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (If Any):

1. https://www.youtube.com/watch?v=-ZR73-49RsY – NPTEL video on Undamped free Vibration
   https://www.youtube.com/watch?v=R7pF2WC4hXQ – Free and Forced Vibration Analysis.

TURBO MACHINES

(Effective from the Academic Year 2024 - 2025)

V SEMESTER

Course Code	BME503T	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Trigonometry and Fluid Mechanics.

COURSE OBJECTIVES:

- Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved.
- Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
- Analyse various designs of steam turbine and their working principle.
- Study the various designs of hydraulic turbine based on the working principle.
- Understand the various aspects in design of power absorbing machine.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance (No numerical questions on dimensional analysis), Unit and specific quantities. **Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbomachines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. Simple Numerical on-stage efficiency and polytropic efficiency.	**10 Hours**

MODULE - II

Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor. General analysis of Radial flow compressors and pumps, Expression for degree of reaction, velocity triangles, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Numerical Problems.	**10 Hours**

MODULE - III

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor. Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical Problems. **Hydraulic Turbines**: Classification, various efficiencies. Pelton Wheel – Principle of working,	**10 Hours**

velocity triangles, design parameters, maximum efficiency, and numerical problems. Francis Turbine – Principle of working, velocity triangles, design parameters, and numerical problems. Kaplan Turbine - Principle of working, velocity triangles, design parameters and Numerical Problems. Theory and types of Draft tubes.	

MODULE - IV

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems. **Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply fundamental thermodynamic principles to explain the working of turbomachines and evaluate their efficiencies using isentropic, stage, and polytropic analyses.	CL3
CO2	Analyze energy transfer in turbomachines using Euler's equations, velocity triangles, and derive relationships for degree of reaction and utilization factor for axial and radial flow machines.	CL4
CO3	Evaluate the performance parameters and efficiency of various steam and hydraulic turbines through velocity triangle analysis and appropriate numerical methods.	CL5
CO4	Design and analyze the performance of centrifugal pumps and compressors considering parameters like NPSH, cavitation, slip factor, and efficiency using theoretical and empirical approaches.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2		1								2			3
CO2	3	3		2								2			3
CO3	3	3	2	2			1					2			3
CO4	3	3	2	2	1		1					2			3

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage

40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2. Turbo Machines, B. U. Pai, Wiley India Pvt, Ltd, 1st Edition.
3. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd, 2nd edition, 2002.
4. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company, 1964.
5. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier, 2005.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://www.youtube.com/watch?v=wlPXZrP9vR8&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2
2. https://www.youtube.com/watch?v=ocVzrn4DLj8&list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE

Non Traditional Machining Processes
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BME504T**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Machining Process

COURSE OBJECTIVES:

- To enable students to understand the need, classification, and criteria for selecting non-traditional machining processes in modern manufacturing.
- To familiarize students with the working principles, equipment, and parameter influences of Ultrasonic and Abrasive Jet Machining processes.
- To impart knowledge on Electrochemical and Chemical Machining processes, focusing on their mechanisms, tooling, parameters, and industrial utility.
- To introduce students to thermal and beam energy-based machining methods like EDM, PAM, LBM, and EBM, along with their applications and limitations.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to Non-traditional Machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.	**10 Hours**

MODULE - II

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. **Abrasive Jet Machining (AJM):** Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.	**10 Hours**

MODULE - III

Electrochemical Machining (ECM): Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH. **Chemical Machining (CHM):** Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.	**10 Hours**

MODULE - IV	
Electrical Discharge Machining (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. **Plasma Arc Machining (PAM):** Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics, Safety precautions, applications, advantages and limitations. **Laser Beam Machining (LBM):** Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations. **Electron Beam Machining (EBM):** Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the selection logic and classification of non-traditional machining processes for various industrial material removal tasks.	CL2
CO2	Interpret the effects of key process variables in Ultrasonic and Abrasive Jet Machining to optimize machining performance.	CL2
CO3	Demonstrate the setup and operating principles of ECM and CHM to achieve desired machining performance and accuracy.	CL2
CO4	Utilize advanced energy-based machining techniques like EDM, PAM, LBM, and EBM for efficient micro and macro machining tasks.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage

40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

- G. F. Benedict, Nontraditional Manufacturing Processes, 1st ed., Marcel Dekker Inc., New York, 1987.
- V. K. Jain, Advanced Machining Processes, 1st ed., Allied Publishers Pvt. Ltd., 2007.
- J. P. Davim, Non-Traditional Machining Processes: Research Advances, Springer, 2013.
- P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill, 1980.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://nptel.ac.in/courses/11210512

FLUID MECHANICS AND MACHINERY LAB
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BME505L**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Basic Knowledge of Fluid Mechanics and Turbomachine

COURSE OBJECTIVES:

- To skill the students in the flow measurements using various types of flow measuring devices, calibration and losses associated with these devices.
- To skill the students to understand the energy conversion in hydraulic turbines and pumps.
- To enable the students to conduct the performance analysis of hydraulic machines.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	To determine the coefficient of Friction in pipes (major losses)
2	To determine the coefficient of Friction in pipe fittings (minor losses)
3	To determine the Coefficient of discharge of Orifice meter
4	To determine the Coefficient of discharge of Venturimeter
5	To determine the Coefficient of discharge of Flow nozzle
6	To determine the Coefficient of discharge of Notches apparatus
7	To determine the Impact of jet on vane apparatus
8	To determine the performance characteristics of Pelton turbine
9	To determine the performance characteristics of Kaplan turbine
10	To determine the performance characteristics of Francis turbine
11	To determine the performance characteristics of Multistage centrifugal pump
12	To determine the performance characteristics of Single stage centrifugal pump
13	To determine the performance characteristics of Reciprocating pump
14	To determine the performance characteristics of Reciprocating air compressor
15	To determine the performance characteristics of Centrifugal air blower test rig

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply Bernoulli's and momentum equations to analyze fluid flow through experimental investigation.	CL 3
CO2	Evaluate fluid flow losses in pipes and fittings using experimental methods.	CL 3
CO3	Determine performance parameters of hydraulic turbines through practical experiments.	CL 3
CO4	Conduct experiments on hydraulic pumps and plot characteristic curves based on observed data.	CL 3
CO5	Determine the performance parameters of compressors and blowers.	CL 3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2							1			2
CO2	3	2	3		2							1			2
CO3	3	2	3		2							1			2
CO4	3	2	3		2							1			2
CO5	3	2	3		2							1			2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.

- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Cimbala, J.M., Cengel, Y. A. (2010),Fluid Mechanics: Fundamentals and Applications, McGraw-Hill
2. Frank M White., (2016), Fluid Mechanics, 8thEdition , McGraw-Hill
3. B.K Venkanna, Fundamentals of Turbo Machinery, PHI Publishers

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. https://archive.nptel.ac.in/courses/112/103/112103249/
2. https://archive.nptel.ac.in/courses/112/104/112104118/

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

SMART MATERIALS

(Effective from the Academic Year 2024 - 2025)

V SEMESTER

Course Code	**BME506E1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Course on Material Science and Metallurgy

COURSE OBJECTIVES:

- Understand the Fundamentals of Smart Materials
- Analyze Material Properties and Behaviors
- Explore Applications in Engineering and Technology
- Design with Smart Materials
- Investigate Emerging Trends and Challenges

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I	
Smart Structures: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements Of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor. **Beam Modeling:** Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezoelectrical Applications	**10 Hours**
MODULE - II	
Shape memory Alloy: Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems. **ER and MR Fluids:** Mechanisms and properties, Fluid Composition and behavior, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clatches, Dampers and Others.	**10 Hours**
MODULE - III	
Vibration Absorbers: series and Parallel Damped Vibrations (OverView), Active Vibration Absorbers, Fiber Optics, Physical Phenomena, Characteristics, Sensors, Fiber Optics in Crack Detection, applications. **Control of Structures:** Modeling, Control Strategies and Limitations, Active Structures in Practice	**10 Hours**
MODULE - IV	
MEMS- Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration. **Devices:** Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	**Course Outcome Description**	**Bloom's Taxonomy Level**

CO1	Understand the behaviour and applicability of various smart materials	CL2
CO2	Design simple models for smart structures & materials	CL4
CO3	Perform simulations of smart structures & materials application	CL4
CO4	Conduct experiments to verify the predictions	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2									2		2	
CO2	3	2	2									2		2	
CO3	3	2	2									2		2	
CO4	3	2	2									2		2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).

Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN :0890066817).

Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

INDUSTRIAL ROBOTICS

(Effective from the Academic Year 2024 - 2025)

V SEMESTER

Course Code	BME506E2	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge of automation systems.

COURSE OBJECTIVES:

- To introduce the fundamentals of robotics and its components.
- To provide knowledge about the sensors and actuators used in robotics.
- To discuss different industrial applications of robots.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction: History, basic concepts of robotics such as definition, three laws, anatomy of a robotic manipulator, classification of robots, robot configurations, degrees of freedom, workspace of manipulators, characteristics of robots, specifications of robots, 4-Ds of robotics, economic analysis. Robot end effectors -Mechanical grippers, magnetic grippers, vacuum grippers, adhesive grippers, active and passive grippers, special tools as end effectors, selection and design considerations of grippers in robot.	**10 Hours**

MODULE - II

Homogeneous transformations: Frame transformation, homogeneous translation matrix, homogeneous rotation matrix, representation of frame in cylindrical and spherical coordinate system with respect to fixed frame, composite rotation matrix, rotation matrix about an application of 3D homogeneous transformations in robotics, numerical problems.	**10 Hours**

MODULE - III

Sensors: Sensor classification - Proprioceptive and Exteroceptive sensors, active and passive sensors, characteristics of sensors, Internal sensors - linear and rotary position sensors, velocity sensors, acceleration sensors, External sensors - force, touch, range, proximity, vision, optic, selection of sensors. **Actuators:** Classification - Electric, Hydraulic, Pneumatic actuators, their advantages and disadvantages, Electric actuators - Stepper motors, DC motors, DC servo motors, AC motors, selection of motors, Hydraulic actuators - components and typical circuit, advantages and disadvantages, Pneumatic actuators - components and typical circuit, advantages and disadvantages.	**10 Hours**

MODULE - IV

Robot programming: Introduction to robot programming, methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS. **Robot applications:** Industrial Applications (Manufacturing, Assembly Automation, Machining, Drilling, Welding, Painting), Consumer Applications (Mobile Robots, Medical Robots, Soft Robots), Collaborative Robots, Cloud Robots, Micro robots, Tele Robots, AGVs, Underwater Robots.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the fundamental concepts and classifications of robots, including manipulator anatomy, degrees of freedom, and robot end effectors.	CL2
CO2	Apply homogeneous transformation matrices to model robotic motion, perform frame transformations, and solve related spatial problems.	CL3
CO3	Select appropriate sensors and actuators based on robotic system requirements and operational environments.	CL3
CO4	Demonstrate the application of robot programming methods and languages in performing basic industrial operations and specialized robotic applications.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2					2		2		3	3		
CO2	3	2	2					2		2		3	3		
CO3	3	2	2					2		2		3	3		
CO4	3	2	2					2		2		3	3		

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Robotics and Control", R. K. Mittal, I. J. Nagrath, TATA McGraw Hill Publishing Co Ltd, New Delhi, 2003.
2. "Industrial Robotics Technology", Mikell. P. Groover, Programming and Applications, McGraw Hill Co, 1995.
3. "Introduction to Robotics", S. K. Saha, TATA McGraw Hills Education, 2014.
4. "Fundamentals of Robotics", Dilip Kumar Pratihar, Narosa Publishing House, 2019.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. https://nptel.ac.in/courses/112105249

Future Mobility Systems
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BME506E3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Automotive Engineering, Mechanical Engineering and Basic electrical and electronics engineering.

COURSE OBJECTIVES:

- Select an appropriate drive strategy for the creation of an electric hybrid vehicle based on available resources.
- Create and formulate fundamental designs for electric vehicles and hybrid electric vehicles.
- Select suitable energy storage systems for use in vehicle applications.
- Recognize different communication protocols and technologies employed in automotive networks.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction of Electric Vehicles: Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs. Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. **HEV:** Configuration of HEV (Series, Parallel, Series-parallel & Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance.	**10 Hours**

MODULE - II

Energy Sources: Different Batteries, Battery characteristics (Discharging &Charging) **Battery Chargers:** Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and charge zone. EV and EV charging standards, V2G, G2V, V2B, V2H.	**10 Hours**

MODULE - III

DC Motor: Type of wound-field DC Motor, Torque speed characteristics, DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed DC motor drive, speed control of DC Motor. **Induction Motor Drive:** Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control	**10 Hours**

MODULE - IV

Electric vehicle drive train: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. **Hybrid electric drive-trains:** Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis **Sizing the drive system:** the propulsion motor, sizing the power electronics, selecting the energy storage technology.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the evolution, key technologies, and configurations of electric and hybrid electric vehicles	CL3
CO2	Interpret the characteristics of different batteries, types of charging methods, and the structure of EV charging infrastructure along with related standards and technologies	CL3
CO3	Describe the operating principles and control methods of DC and induction motor drives used in electric vehicle applications.	CL3
CO4	Understand the structure and operation of electric and hybrid drive train topologies and the considerations involved in sizing motors, power electronics, and energy storage systems.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40 %	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Modern Electric Vehicle Technology" by C.C Chan, K.T Chau, Oxford University Press Inc., New York 2001
2. "Electric and Hybrid Vehicles: Design Fundamentals," by CRC Press, 2003.
3. "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design" by Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 2004
4. "Electric Vehicle Battery Systems" by Sandeep Dhameja, Newnes, 2000
5. "Hybrid Vehicles and the Future of Personal Transportation" by A. E. Fuhs, CRC Press, 2009.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://nptel.ac.in/courses/108103009
2. https://www.youtube.com/watch?v=rK6Bey_loiw

OPERATIONS RESEARCH
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	BME506E4	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Mathematics

COURSE OBJECTIVES:

- To introduce the fundamentals of Operations Research and linear programming models for optimization.
- To develop problem-solving skills using transportation, assignment, and travelling salesman problems.
- To impart knowledge on project scheduling through network analysis and decision-making using queuing models.
- To introduce strategic decision-making using game theory and sequencing techniques for optimizing operations.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction: Evolution of OR, Definitions of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, Linear Programming Problem (LPP), Generalized LPP-Formulation of problems as LPP, Solutions to LPP by graphical method (Two Variables). **LPP:** Simplex method, Canonical and Standard form of LPP, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and two-phase Simplex Method.	**10 Hours**

MODULE - II

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method, Optimality in Transportation problem by Modified Distribution (MODI) method, Unbalanced TP, Maximization TP. **Assignment Problem:** Formulation, Solutions to assignment problems by Hungarian method, unbalanced, Maximization assignment problems, Travelling Salesman Problem (TSP), Difference between assignment and TSP, Finding best route by Little's method, Numericals.	**10 Hours**

MODULE - III

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project. **Queuing Theory:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numericals on M/M/1 and M/M/C Queuing models.	**10 Hours**

MODULE - IV

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.	**10 Hours**

Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Formulate and solve linear programming problems using graphical and simplex-based methods including Big-M and two-phase techniques.	CL3
CO2	Apply optimization techniques to solve transportation, assignment, and travelling salesman problems using methods like MODI and Hungarian.	CL3
CO3	Analyze project timelines using PERT/CPM and evaluate service systems using queuing theory models such as M/M/1 and M/M/C.	CL3
CO4	Solve decision-making problems using game theory and sequencing models to optimize operations across various machine-job configurations.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2									2		2	
CO2	3	2	2									2		2	
CO3	3	2	2									2		2	
CO4	3	2	2									2		2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Operations Research P K Gupta and D S Hira S. Chand and Company LTD. Publications, New Delhi 2007
2. Operations Research, An Introduction Hamdy A. Taha PHI Private Limited Seventh Edition, 2006.
3. Operations Research, Theory and Applications J K Sharma Trinity Press, Laxmi Publications Pvt.Ltd. Sixth Edition, 2016
4. Operations Research Paneerselva n PHI
5. Operations Research A M Natarajan, P Balasubram ani Pearson Education, 2005
6. Introduction to Operations Research Hillier and Lieberman McGraw Hill 8th Ed

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://nptel.ac.in/courses/110106062

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS
(Effective from the Academic Year 2024-2025)
SEMESTER – V

Course Code	**BBS508AK**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	16L	Exam Hours	03

CREDIT– 1

COURSE PREREQUISITES:

- A foundational understanding of research and knowledge of research problem formulation, familiarity with academic ethics, a basic understanding of statistics and data analysis, ability to search and evaluate academic sources, basic writing and communication skills, critical thinking skills, time management skills and awareness of ethical considerations in research.

COURSE OBJECTIVES:

- Understand the basic concepts, principles, and types of research methodologies
- Collect, analyze, and interpret data using relevant techniques.
- Ethically conduct research and adhere to academic integrity.
- Communicate research findings effectively through written and oral presentations.
- Understand the intellectual property rights and the types of IPR.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporated into the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem-Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to Research Methodology and Literature Review **Introduction to Research Methodology:** Meaning of research, Objectives of research, Types of research, Importance of scientific research in decision making, Defining the research problem, techniques involved in defining a problem**.** Research Design: Meaning of research design, need for research design, Features of good design. **Literature Review:** Significance of literature review, Sources for literature: Books, Journals, Proceedings, Thesis and Dissertations. Online databases: Web of Science, Google and Google Scholar. Quality research papers**.** Research metrics: Citation, Citation Index, Impact Factor, H-index, i10-index, Google index and their significance. **Ethics in Research** Ethics with respect to research, ethical principles, the importance of adhering to ethical norms in research, research misconducts, plagiarism, penalties for plagiarism, publication ethics, conflict of interest, publication misconduct, violation of publication ethics and authorships, identification of publication misconduct, complaints and appeals (examples) and Open Access Publishing. ***Text books: 1, 2, 3.***	**4 Hours**

MODULE – II	
Data Collection, Analysis and Report Writing **Data Collection:** Introduction, collection of primary data: observation method, questionnaires and case study method, collection of secondary data, Selection of an appropriate method for data collection. **Data Analysis**: Introduction, Data analysis process, Types of data analysis, Methods of data analysis: Qualitative analysis, Quantitative analysis. Tools for data analysis. **Report Writing:** Effective technical writing, Steps for writing a report, structure of the research report, method of writing a research article (manuscript)/ research report, crafting effective project proposals, Paper writing for National and international journals, submitting papers to journals (Scopus Indexed Journals, Science Citation Indexed journals), preparation of effective slides, pictures, and graphs for presentation. ***Text books: 1, 2.***	**4 Hours**

MODULE - III	
Intellectual Property Rights, Patents and Industrial Designs: **Intellectual Property Rights**: Introduction to intellectual property and intellectual property rights, objectives of IPR, History of IPR in India, Role of WIPO and WTO in IPR establishments, Types of Intellectual property rights. **Patents:** Introduction to patent, need and importance of a patent, requirements of patent, types of patents, few famous examples of patent, patentable and non-patentable items, Duration, limitations of a patent, the Indian Patent Act-1970, Rights associated with patents, Enforcement of patent rights, Patent infringements. Case Studies on Patents**:** Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent **Industrial Designs:** Design introduction, Features of Design, Design law 2000, Registration of Design, Need for registration of Design, Procedure for registration of Design, Infringement of Design. Famous Case Law: Apple Inc. vs. Samsung Electronics Co. ***Text books: 4, 5.***	**4 Hours**

MODULE - IV	
Copyrights, Trademarks and Geographical Indications: **Copyrights:** Introduction to copyright, characteristics of copyright, copyright-National Vs international, Indian copyright Act-1957, Indian perspective on copyright, Term/duration of copyright, registration of copyright, copyright symbol, procedure of copyright certification, benefits of copyright registration, copyright infringement, limitations of copyright. **Trademarks:** Introduction to Trademark, signs which may serve as Trademarks, functions of Trademark, Essential features of Trademark, Types of Trademark, the validity of the trademark, Unfair competition, Trademark Act 1999, Infringement of Trademark, Famous case law: Coca-Cola Company vs. Bisleri International Pvt. Ltd. **Geographical Indications:** Introduction to G.I, History of G.I, G.I Act 1999, Registration of G.I, Registration process of G.I, Duration of G.I Tag, Infringement of G.I, Some important G.I Tags. ***Text books: 4, 5.***	**4 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Comprehend the process of research methodology to define a research problem.	CL2
CO2	Understand the analytical tools for the analysis and interpretation of data.	CL2
CO3	Illustrate the significance of Intellectual property rights and of research projects for economic growth and social benefits.	CL2
CO4	Demonstrate the copyright laws, subject matters of copyrights and Trademarks.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)											Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3	1	1			2	3	1	1	1	2		
CO2	3	2	1	1	1	1	1	1		2			
CO3	3	2	2	2	1	2	3	1	1	1	2		
CO4	3	2	2	2	1	2	3	1	1	1	2		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)			

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignment	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

CO - ASSESSMENT MAPPING

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
40%	30%	30%	100%	100%
M1			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV

NOTE

- Assessment will be both CIA and SEE.
- The assignment of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

1. The question paper will include Multiple Choice Questions (MCQs) from all four modules.
2. There will be a total of 50 questions, each carrying 2 marks.
3. Students are required to attempt all the questions.

TEXT BOOKS:

1. Kothari C R and Gaurav Garg, Research Methodology Methods and Techniques, Fourth Edition by, New Age International, 2019.
2. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson Education, Australia, 2005.
3. Pratim Ray, Partha "A Guide to Research and Publication Ethics" First edition, New Delhi Publishers c2022.
4. Deborah E Bouchoux, Intellectual Property Rights by CENGAGE Learning.
5. Rupinder Tewari and Mamta Bhardwa, Intellectual Property A Primer for Academia.

REFERENCE BOOKS:

1. David V. Thiel “Research Methods for Engineers” Cambridge University Press, 978-1-107-03488-4.
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. Acharya N K, Intellectual Property Rights, Asia Law House 6th Edition. ISBN: 978-93-81849-30-9

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. https://nptel.ac.in/courses/106/105/106105077/
2. https://youtu.be/oPXyj3mAEKg
3. https://youtu.be/E2gGF1rburw
4. https://www.youtube.com/watch?v=VzIgPfAd0Fs&list=RDCMUCLVol4Vq_9CKVYNv4tDZhXw&start_radio=1&rv=VzIgPfAd0Fs&t=0

Assignments:

1. **Case Study:** Conduct a literature survey on a suitable research topic and prepare a report with a minimum of 10 references that adheres to standard journal specifications.
2. **Case Study:** Download 5 quality research papers published within the last five years from reputed journals on the topic of your choice and provide your analysis and perspective on the chosen topic
3. **Case Study:** Conduct a prior art search using free online databases and prepare a report.

ENVIRONMENTAL STUDIES

(Effective from the Academic Year 2024-2025)

V SEMESTER

Course Code	**BBS509TK**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**16L**	Exam Hours	01

CREDITS – 1

COURSE PREREQUISITES:

- Fundamental knowledge of Ecosystems, Environment Pollution and its effects.

COURSE OBJECTIVES:

- To create environmental and sustainability awareness among the students.
- To educate the students to understand the various environmental pollutants, waste management techniques, and the legal framework governing environmental protection.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Ecosystem and Sustainability: — **4 Hours**

Structure and function of ecosystems in Forest, Desert, Wetlands, River, Oceanic and Lakes. Sustainability: 17 SDGs- History, targets, implementation, Capacity Development. Marine ecosystem and its conservation.
Success stories - best practices related to urban ecosystem conservation, plastic pollution control and sustainable innovations.

MODULE - II

Advances in Energy Systems and Sustainable Practices: — **4 Hours**

Hydrogen, Solar, OTEC, Tidal, and Wind energy systems: (Merits and Demerits. Global status and applications of renewable energy sources.) Concepts and case studies in disaster management with a focus on technology and data-driven solutions.
Bioenergy - Use of biomass, biogas, and biofuels in the context of renewable energy - their environmental impacts, sustainability, and applications.
Case studies on Sustainable mining practices and their environmental impact. Carbon trading, its role in reducing carbon emissions & Green certification.

MODULE - III

Environmental Pollution, Global Issues and Waste Management — **4 Hours**

Environmental Pollution and global issues: Sources, impacts, and control of surface and ground water pollutants. Soil pollutants and their effects on ecosystems. Air pollutants and their consequences on air quality, ozone depletion. Radon and fluoride concentration in drinking water and potential health risks. Environmental toxicology - causes and control measures.

Waste Management: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge. Solid waste management: sources, characteristics, health hazards, and disposal methods of E-Waste and Plastic waste. Different approaches of recycling and metal recovery from E-Waste. Role of stake holders in environmental management of e-waste (producers, consumers, recyclers, and statutory bodies). Strategies for plastic pollution control.	

MODULE - IV

Environmental Legislation and Sustainable Green Technologies **Environmental Legislation:** Water Act 1974, Air Act 1981, Environmental Protection Act 1984, Solid Waste Management Rules-2016, E- Waste management Rule - 2022, Biomedical Waste management- 2016 and The Biological Diversity Act, 2002. **Sustainable Green Technologies** Sustainable agriculture practices and green technologies. Waste-to-Energy Technologies. Introduction to circular economy principles and green data centre technologies.	**4 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Summarize the role of Engineers in maintaining the ecosystem functionalities and sustainable development in the field of environmental science.	CL2
CO2	Understand the advances in energy systems and approaches relevant to natural resource management.	CL2
CO3	Illustrate the sources, impacts & control of environmental pollution and understand the process involved in solid waste management.	CL2
CO4	Summarize global environmental challenges and sustainable solutions in relation to environmental legislation, waste management, and biological diversity preservation.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11		1	2
CO1														
CO2														
CO3														
CO4														
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)				

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Practical Session (Laboratory Component)	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

CO - ASSESSMENT MAPPING

Continuous Internal Assessment (CIA) (50%)			Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Practical Sessions (40%)
I	II	III	

Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	**30%**	**30%**	**100%**	**100%**
M1			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV

NOTE

- Assessment will be both CIA and SEE.
- The practical sessions of the IPCC shall be for CIE only.
- The Theory component of the IPCC shall be for both CIA and SEE respectively.
- The questions from the practical sessions shall be included in Theory SEE.

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The Question paper will have **FIFTY** multiple choice questions covering the entire four module syllabus.
- Each question may have a maximum of four sub-questions and each question will be for 01 mark.
- Examination will be **ONLINE** and students will have to answer all the questions.
- The Duration of the Exam will be 01 hour.

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

Field work: Visit to Zero Waste Management Plant / Solid waste management plant/Biogas production plant.

TECHNOLOGY ENTREPRENEURSHIP AND BUSINESS ECONOMICS
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	BME601T	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental concepts of management, economics, costing, finance and marketing.

COURSE OBJECTIVES:

- To introduce the fundamental principles of management including planning, organizing, staffing, directing, and controlling.
- To develop an entrepreneurial mindset, understanding the startup ecosystem, and the role of entrepreneurship in economic development.
- To equip students with marketing and venture creation strategies relevant to startup growth and sustainability.
- To provide foundational knowledge of economics, costing, depreciation, and financial evaluation techniques used in business decision-making.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management, Management & Administration - Roles of Management, Levels of Management, Scientific Management, Planning: Nature, importance and purpose of planning process, Organizing and Staffing: Nature and purpose of organization, Principles of organization, Nature and importance of staffing, Process of Selection & Recruitment (in brief). Directing & Controlling: Meaning and nature of directing, Leadership styles, Motivational Theories- only Maslow's theory, Communication - Meaning and importance - coordination, meaning and importance and steps in controlling - Essentials of a sound control system.	**10 Hours**

MODULE - II

Entrepreneurship: Role of entrepreneurship in economic development; Entrepreneurial mindset, motivation and competencies; Market pull and technology push factors; New product development lifecycle; Technology readiness levels; Product-market fit validation; Commercialization pathways; Business vision & leadership; Team composition & management, Financial Institutions and Small-scale Industries, Govt. Policies for SSIs. Case studies on Indian Start-ups.	**10 Hours**

MODULE - III

Marketing: Market segmentation & market sizing; Customer persona & value proposition; Marketing (Go-to-market) strategy; Distribution channels and sales network; Funding requirement (based on stage); Source of funding for startup ventures. **Venture Creation:** Sustainable business options & pathways; Business model & business canvas; Startup team & business partners; Startup ecosystem and stakeholders; Technology business incubators & parks; Proposal pitching & agreements; Startup company incorporation; Social impact & responsibility.	**10 Hours**

MODULE - IV	
Introduction to Economics: Economics, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, elasticity of demand, price elasticity, income elasticity. Time value of money, Interest and interest factors, types of compound interest problems, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems. Present, future and annual worth: Basic present worth comparisons, Present worth equivalence, Assets with unequal lives, future worth comparisons, equivalent annual worth comparisons, Discussions and problems. **Costing and Depreciation:** Components of costs, estimation of selling price, marginal cost, first cost, types of overheads, indirect cost estimation, estimation of material cost, cost estimation of mechanical process, idling time. causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply management principles and demonstrate understanding of planning, organizing, staffing, directing, and controlling functions in business environments.	CL3
CO2	Analyze the role of entrepreneurship in economic development and assess startup development stages, including financial and policy aspects.	CL3
CO3	Develop go-to-market strategies, evaluate funding sources, and design sustainable business models using tools like the business model canvas.	CL3
CO4	Solve basic problems in economics, cost estimation, depreciation, and financial analysis using standard engineering economic techniques.	CL3

CO-PO-PSO MAPPING															
CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										2		2			
CO2										2		2			
CO3										2		2			
CO4	3	2										2		2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Mechanical estimation and costing T.R. Banga& S.C. Sharma Khanna Publishers 17th edition
2. Engineering Economy Riggs J.L McGraw Hill 24t0h1 5e dition
3. Engineering Economy Thuesen H.G PHI 22000022
4. Principles of Management Tripathy and Reddy Tata McGraw Hill 3rd edition 2006
5. Mechanical estimation T.R. Banga& S.C. Sharma Khanna Publishers 17th edition
6. Engineering Economy Riggs J.L McGraw Hill 4th edition
7. Byers, Dorf, and Nelson, Technology Ventures: From Ideas to Enterprise, McGraw Hill, 2010
8. Steve Blank, “The Startup Owner's Manual”
9. T.V. Rao, “Entrepreneurship - A South Asian Perspective.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://onlinecourses.nptel.ac.in/noc22_ge03/preview
2. https://onlinecourses.nptel.ac.in/noc23_ec06/preview
3. https://archive.nptel.ac.in/courses/110/105/110105067/

HEAT TRANSFER
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	BME602G	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Mathematics & Engineering Thermodynamics

COURSE OBJECTIVES:

Student will be able to learn

- Principles of heat transfer.
- Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate systems.
- Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.
- Radiation heat transfer mechanism.
- Understand performance parameters of heat exchangers.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- PowerPoint Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Modes of heat transfer; Basic laws governing modes of heat transfer. Conduction-Basic Equations: Derivation of general form heat conduction equation in rectangular coordinates. Types of boundary conditions, Thermal resistance in series and in parallel. **One-dimensional steady state conduction:** Steady state conduction in a slab, cylinder and sphere with and without heat generation, Composite wall, overall heat transfer coefficient, critical thickness of insulation.	**10 Hours**

MODULE - II

Fins: Heat transfer in extended surfaces of uniform cross-section without heat generation, long fin, short fin with insulated tip and without insulated tip. Fin efficiency and effectiveness.	**10 Hours**

Numerical problems. **One-Dimensional Transient Conduction:** Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder, and sphere; Numerical Problems.	
MODULE - III	
Free or Natural Convection: Application of dimensional analysis for free convection physical significance of Grashoff number; use of correlations of free convection in vertical, horizontal, and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical problems. **Forced Convection:** Applications of dimensional analysis for forced convection. The physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems.	**10 Hours**
MODULE - IV	
Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers, Compact heat exchangers. Numerical problems. **Radiation Heat Transfer:** Radiation laws, Thermal radiation; Radiation heat exchange between two parallel infinite black surfaces and infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Numerical problems.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply basic laws of heat transfer to understand conduction, convection, and radiation in thermal analysis of engineering systems.	CL3
CO2	Analyze unsteady-state heat transfer problems in lumped system and semi-infinite solids using transient models.	CL4
CO3	Evaluate natural and forced convection heat transfer in internal and external flows such as ducts, cylinders, and flat plates.	CL5
CO4	Perform preliminary design and analysis of heat exchangers using LMTD and effectiveness-NTU methods, and apply radiation heat transfer principles.	CL5

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Determination of Thermal Conductivity of a Metal Rod.	CO1	CL4
2.	Determination of Overall Heat Transfer Coefficient of a Composite wall.	CO1	CL4
3.	Experiment on Transient Conduction Heat Transfer.	CO2	CL4
4.	Determination of efficiency and Effectiveness of the fin by natural convection using pin fin apparatus	CO2	CL4
5.	Determination of efficiency and Effectiveness of the fin by forced convection using pin fin apparatus	CO2	CL4
6.	Determination of Heat Transfer Coefficient in free Convection.	CO3	CL4

7.	Determination of Heat Transfer Coefficient in a Forced Convention.	CO3	CL4
8.	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.	CO4	CL4
9.	Determination of LMDT and Effectiveness in a Parallel Flow Heat Exchangers.	CO4	CL4
10.	Determination of LMDT and Effectiveness in a Counter Flow Heat Exchangers.	CO4	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2		1			1					2			3
CO2	3	3		2								2			3
CO3	3	3		2			1					2			3
CO4	3	3	2	2	1		2					2			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.
2. Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition
3. Heat and mass transfer Kurt C, Rolle Cengage learning second edition.
4. Heat Transfer A Basic Approach M. NecatiOzisik McGraw Hill, New York 2005.
5. Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5th Edition 2006.
6. Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (If Any):

1. CFD Analysis of Shell and Tube Heat Exchanger- https://youtu.be/jwdNeW690MI
2. NPTEL Heat Transfer course for Mechanical Engineering, http://nptel.ac.in/courses/112101097/
3. NPTEL Conduction and Convection Heat Transfer- https://youtu.be/IedD23t5jI4
4. NPTEL Importance of Thermal Radiation- https://youtu.be/aLwJKZ1Gf3g

DESIGN OF MACHINE ELEMENTS I
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	BME603T	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Engineering Mechanics, Mechanics of Materials, Engineering Machine Drawing.

COURSE OBJECTIVES:

- To understand the various steps involved in the Design Process.
- To understand the principle involved in design of machine elements, subjected to different kinds of forces, considerations of strength, rigidity, functional and manufacturing requirements.
- To understand the concept of impact strength and fatigue strength in the design.
- To develop the capability to design elements like shafts, couplings, welded joints, screwed joints, and power screws.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction: Design Process: Definition of design, phases of design, and review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. **Design of machine members** under axial, bending, shear and torsion loading. **Design of Curved beams**: Crane hook, punching presses and clamps, closed rings.	**10 Hours**

MODULE - II

Impact Strength: Introduction, Impact stresses due to axial, bending and torsion loads. **Fatigue loading:** Types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, size effect, surface effect, Stress concentration effects Notch sensitivity, Soderberg and Goodman relationships, stresses due to combined loading.	**10 Hours**

MODULE - III

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, design of shafts subjected to combined bending, torsion and axial loading. Design of shafts subjected to fluctuating loads. **Design of keys and couplings:** Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling.	**10 Hours**

MODULE - IV

Permanent Joints: Design of Welded joints, Types, strength of butt and fillet welds, eccentrically loaded welded joints. **Temporary Joints:** Types of temporary joints- cotter joints, knuckle joint and fasteners. Design of Cotter and Knuckle Joint. **Power screws:** Mechanics of power screw, stresses in power screws, efficiency and self-locking, design of power screws.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the mechanical behavior of machine components under axial, bending, shear, and torsional loads.	CL4
CO2	Analyze the design of machine element subjected to impact and fatigue loading.	CL4
CO3	Analyze the design requirements of shafts, keys, and couplings under various loading conditions.	CL4
CO4	Analyze the design and performance of permanent and temporary joints under different loading conditions.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1		2			1	1	1		2	2		
CO2	3	2	1					1	1	1		2	2		
CO3	3	2	1		2			1	1	1		2	2		
CO4	3	2	1					1	1	1		2	2		

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02

6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Shigley's Mechanical Engineering Design" by Richard G. Budynas, and J. Keith Nisbett, McGraw-Hill Education, 11th edition, 2020.
2. "Design of Machine Elements" by V B Bhandari, Tata McGraw Hill, 5th edition, 2020.
3. "Machine Design" by Robert L. Norton, Pearson Education, 5th Edition, 2018.
4. "Design of Machine Elements" by Dr. M H Annaiah Dr. J Suresh Kumar, New Age International, 1st Edition, 2016.
5. "Elements of Machine Design" by H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil, IK International, First Edition, 2019.

DESIGN DATA HAND BOOK:

1. Design Data Hand Book by K. Mahadevan and Balaveera Reddy, CBS Publication, 4th Revised edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. Design of Machine Elements https://nptel.ac.in/courses/112/106/112106137/
2. Design of Machine Elements https://nptel.ac.in/courses/112/105/112105125/
3. Design of Machine Elements https://nptel.ac.in/courses/112/105/112105124/

HYDRAULICS AND PNEUMATICS
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	BME604E1	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge about hydraulic and pneumatic systems

COURSE OBJECTIVES:

- Understand the basic hydraulic and pneumatic system and their techniques.
- To understand the concept and operation principle of automation systems and their controls.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to hydraulic systems: Pascal's law, source of hydraulic power, pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance. **Hydraulic actuators and motors**: Linear hydraulic actuators (cylinders), mechanics of hydraulic cylinder loading, rotary hydraulic actuators, gear motors, vane motors and piston motors. **Control components in hydraulic systems:** Directional control valves, symbolic representation, constructional features, pressure control valves - direct and pilot operated types, flow control valves. **Maintenance of hydraulic systems:** Hydraulic oils, desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers.	**10 Hours**

MODULE - II

Introduction to Pneumatic systems: Choice of working medium, characteristics of compressed air, preparation of compressed air: filters, regulators, lubricators, compressed air conditioning, air recirculation. **Pneumatic actuators:** Linear actuators (cylinders) and their types, conventional type of cylinder working, end cushioning, seals, rod less cylinders and their types, rotary actuators and their types, air motors. **Control components in pneumatic systems**: Directional Control valves, design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.	**10 Hours**

MODULE - III

Hydraulic Circuit Design: Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors. **Pneumatic Circuit Design:** Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling, Use of Logic gates - OR and AND gates in pneumatic applications, Automatic reciprocation of pneumatic cylinders.	**10 Hours**

MODULE - IV

Multi-cylinder Applications: Coordinated and sequential motion control, Motion and control diagrams, Multi-cylinder circuit design methods- Classic method, Signal elimination methods- idler roller & cascading method, principle & application examples (up to two cylinders). **Electro-Pneumatic control:** Electrical control devices- push button switch, limit switch, pressure switch, relays, solenoid operated DCVs, electro-pneumatic control circuitry for single and double acting cylinder applications.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:		
CO No.	**Course Outcome Description**	**Bloom's Taxonomy Level**
CO1	Apply the principles of hydraulic systems and components to analyze and troubleshoot basic fluid power circuits used in industrial applications.	CL3

CO2	Apply the working principles of pneumatic actuators and control components to develop basic pneumatic circuits for industrial applications.	CL3
CO3	Analyze hydraulic and pneumatic circuits to determine the functional behavior of actuators, control strategies, and sequence operations in fluid power systems.	CL4
CO4	Evaluate multi-cylinder and electro-pneumatic circuits to determine control sequences and select appropriate components for industrial automation applications.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		2			2				2		3	
CO2	3	3	2		2			2				2		3	
CO3	3	3	2		2			2				2		3	
CO4	3	3	2		2			2				2		3	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Fluid Power with applications", Anthony Esposito, 7th Edition, Pearson India Education, New Delhi, 2013.
2. "Hydraulics and Pneumatics", Andrew Parr, 9th Edition, Jaico Publishing house, 2005.
3. "Oil Hydraulic Systems", S.R. Majumdar, 1st Edition, Tata McGraw Hill, 2002.
4. "Pneumatic Systems", S.R. Majumdar, 1st Edition, Tata McGraw Hill, 2002.
5. "Hydraulics and Pneumatics", Jagadeesha T, I.K. International Publishing House Pvt. Limited, 2015.

REFERENCE WEB LINKS AND VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/106/112106300/
2. https://archive.nptel.ac.in/courses/112/105/112105047/

INDUSTRIAL AUTOMATION AND CONTROL

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BME604E2**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Material Science, metal forming

COURSE OBJECTIVES:

- To introduce the fundamentals of automation and computer-integrated manufacturing systems.
- To provide insight into automated production lines, flow lines, and assembly systems with practical performance analysis.
- To familiarize students with industrial control systems using PLC, ladder logic, and control philosophies.
- To train students in using advanced PLC functions, timers, counters, and arithmetic operations for industrial applications.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.	**10 Hours**

MODULE - II

Automated Production Lines and Assembly Systems: Fundamentals, system configurations, applications, automated flow lines, buffer storage, control of production line, analysis of transfer lines, analysis of flow lines without storage, partial automation, analysis of automated flow lines with storage buffer, fundamentals of automated assembly systems, numericals.	**10 Hours**

MODULE - III

Nature of Industrial Process: Continuous & discrete state sequential process, process variables and their classification. Introduction to Process Control Philosophies: type of relays, ladder logic methodology, ladder symbols. **Introduction to PLC:** Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, and memory structure of PLC. **PLC programming methodologies:** ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC.	**10 Hours**

MODULE - IV

PLC functions: Bit logic instructions, ladder diagram examples, interlocking, latching, interdependency and logical functions, PLC Timer & Counter functions on-delay timer, off-delay timers, retentive on-delay timers, pulse timers, timer examples, up-counter, down-counter and up-down counter, counter-examples, register basics. **PLC Data Handling:** Data move instructions, table and register moves, PLC FIFO & LIFO functions. PLC arithmetic and logical functions: addition, subtraction, multiplication, division instructions, increment decrement, trigonometric and log functions, AND, OR, XOR, NOT functions, PLC compare and convert functions.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the concepts of production system automation and use performance measures to solve numerical problems.	CL3
CO2	Apply the concepts of automated production and assembly line systems to determine performance and efficiency under various configurations.	CL3
CO3	Demonstrate the ability to design and interpret basic PLC architectures and programming methodologies using ladder logic.	CL3
CO4	Implement PLC functions, timers, counters, and data handling operations for effective industrial automation control.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	2				2				2	3	2	
CO2	3	3	3	2				2				2	3	2	
CO3	3	2	3		2			2				2	3	2	
CO4	3	3	3		3			2				2	3	2	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02

6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. JOHN WEBB: Programmable Logic Controllers Principles & applications, PHI
2. T. A. HUGHES: Programmable Controllers
3. C. D. JOHNSON: Process Control Instrumentation

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. **https://www.youtube.com/watch?v=49RET0NITY&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS**
   1. **https://www.youtube.com/watch?v=eFU7tSld7Yc&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS&index=2**

REFRIGERATION AND AIR-CONDITIONING
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BME604E3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering
- Fluid Mechanics
- Thermodynamics
- Heat transfer

COURSE OBJECTIVES:

- Study the basic definition, ASHRAE nomenclature for refrigerating systems.
- Understand the working principles and applications of different types of refrigeration systems.
- Study the working of air conditioning systems and their applications.
- Identify the performance parameters and their relations of an air conditioning system.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I	
Introduction to Refrigeration: Basic definitions, ASHRAE nomenclature, Air Refrigeration Cycles - Reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems - merits and demerits and applications; Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air. **Industrial Refrigeration:** Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous.	**10 Hours**
MODULE - II	
Vapour Compression Refrigeration System: Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP, Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure, Multi-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and Water inter cooling.	**10 Hours**
MODULE - III	
Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems. **Other types of Refrigeration systems:** Brief Discussion on Steam-Jet refrigeration system and Thermoelectric refrigeration, pulse tube refrigeration, thermoacoustic refrigeration systems	**10 Hours**
MODULE - IV	
Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems- Central Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems. **Transport air conditioning Systems:** Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the performance of various air refrigeration and air liquefaction cycles such as Bell-Coleman, Linde, Claude, and Stirling, and assess their suitability for industrial and aircraft applications.	CL4
CO2	Analyze the vapour compression refrigeration cycle and its modifications (Grindlay, Lorenz, multi-pressure systems) to determine their effect on system COP and performance under varying conditions.	CL4
CO3	Analyze vapour absorption refrigeration systems, including water–ammonia and lithium–bromide systems, and compare them with other refrigeration technologies like steam-jet and thermoelectric systems in terms of practicality, efficiency, and applications.	CL4
CO4	Analyze air-conditioning systems (central, unitary, window, packaged) and evaluate their load requirements and design features for different transport and stationary applications.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	1			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	1			1	1	1				1			3

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05

4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses– Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. C. P. Arora, Refrigeration and Air Conditioning, 3rd ed., New Delhi: McGraw Hill Education, 2010.
2. W. F. Stoecker and J. W. Jones, Refrigeration and Air Conditioning, 2nd ed., New Delhi: McGraw-Hill, 1982.
3. S. C. Arora and S. Domkundwar, Refrigeration and Air Conditioning, New Delhi: Dhanpat Rai Publications, Reprint 2020.
4. PITA, Air Conditioning, 4th ed., New Delhi: Pearson Education, 2005.
5. R. J. Dossat and T. J. Horan, Principles of Refrigeration, 5th ed., Boston: Pearson, 2001.
6. W. J. McQuiston, J. D. Parker, and J. D. Spitler, Heating, Ventilating, and Air Conditioning: Analysis and Design, 6th ed., Hoboken, NJ: Wiley, 2005.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://archive.nptel.ac.in/courses/112/105/112105129/

TECHNOLOGIES FOR CLEAN ENERGY
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BME604E4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering, Thermodynamics

COURSE OBJECTIVES:

- Learn about the solar energy and its conversion methods.
- Study the principles of wind, biomass and ocean energy conversion systems.
- Study the principles of energy harnessing in the hydroelectric power generation.
- Become knowledgeable about nuclear reactions, energy conversion techniques, nuclear risks, and disposal.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I	
Solar Energy: Introduction, Solar radiation at the earth's surface, beam, diffuse and global radiation. **Measurement of Solar Radiation:** Schematic diagrams and principle of working of Pyrometer, Pyrheliometer, sunshine recorder. **Solar Thermal Conversion:** Liquid flat plate collectors, concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage. **Application of Solar Energy:** Water heating. Space heating and cooling, active and passive systems, distillation, solar pond. **Photovoltaic Conversion:** Description, principle of working and characteristics, applications.	**10 Hours**
MODULE - II	
Wind Energy: Availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power. Wind machines: Types of wind machines, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design. **Biomass Energy:** Photosynthesis, photosynthetic oxygen production, energy plantation. Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants- KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft.	**10 Hours**
MODULE - III	
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations. **Ocean Thermal Energy Conversion:** Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC. **Geothermal Energy Conversion:** Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.	**10 Hours**
MODULE - IV	
Hydroelectric Plants: Advantages & disadvantages of water power, detailed classification of hydroelectric plants, General layout of hydel power plants - components such as Penstock, surge tanks, spillway and draft tube and their applications, pumped storage plants, storage and pondage, water hammer. Hydrographs and flow duration curves. Numericals. **Hydrogen Energy:** Properties of Hydrogen with respected to its utilization as a renewable form of	**10 Hours**

energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos-chemical production, bio-chemical production.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the principles of solar radiation and thermal/photovoltaic conversion systems to select appropriate technologies for water heating, space conditioning, and power generation.	CL3
CO2	Apply the fundamental concepts of wind energy and biomass conversion to identify suitable systems for small- and large-scale energy generation.	CL3
CO3	Apply the working principles of tidal, ocean thermal, and geothermal energy systems to propose feasible solutions for site-specific energy extraction.	CL3
CO4	Apply the principles of hydroelectric and hydrogen energy systems to analyze their components, operations, and energy output for real-world renewable energy applications.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	1			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	1			1	1	1				1			3

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05

4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses– Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 3rd ed., New Delhi: Tata McGraw-Hill, 2008.
2. G. D. Rai, Non-Conventional Energy Sources, 5th ed., New Delhi: Khanna Publishers, 2011.
3. P. K. Nag, Power Plant Engineering, 4th ed., New Delhi: McGraw Hill Education, 2017.
4. S. Arora and S. Domkundwar, Power Plant Engineering, 6th ed., New Delhi: Dhanpat Rai & Co. Pvt. Ltd., Reprint 2022.
5. B. H. Khan, Non-Conventional Energy Resources, 4th ed., New Delhi: McGraw Hill Education, 2017.
6. R. K. Rajput, Power Plant Engineering, 6th ed., New Delhi: Laxmi Publications, 2020.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_ge04/preview

NON-CONVENTIONAL ENERGY SOURCES
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BME605Q1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Elements of Mechanical Engineering, Thermodynamics

COURSE OBJECTIVES:

- Learn about the solar energy collection, storage, conversion methods and applications.
- To introduce the concepts and applications of Wind energy, Biomass energy, Geothermal energy and Ocean energy as alternative energy sources.
- To explore society's present needs, future energy demands and energy conservation methods.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Energy source: India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, solar, thermal, photovoltaic. Water power, wind biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages. **Solar Radiation:** Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data.	**10 Hours**

MODULE - II

Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. **Solar Thermal Conversion:** Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, Principles of solar pond. **Photovoltaic Conversion:** Description, principle of working and characteristics, application.	**10 Hours**

MODULE - III

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, elementary design principles; coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design, numerical examples. **Tidal Power:** Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations. **Ocean Thermal Energy Conversion:** Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC.	**10 Hours**

MODULE - IV

Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy. **Energy from Bio Mass:** Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas,	**10 Hours**

application of bio-gas in engines, advantages.
Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos-chemical production, bio-chemical production.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply knowledge of India's energy scenario and various renewable energy sources—including solar, wind, water, biomass, tidal, and nuclear—to compare energy alternatives based on their characteristics and utility.	CL3
CO2	Apply the principles of solar radiation measurement and thermal/photovoltaic energy conversion to evaluate the performance of solar energy systems for heating and power applications.	CL3
CO3	Apply wind energy and ocean-based energy conversion principles—including wind turbines, tidal, and OTEC systems—to determine the feasibility and limitations of their implementation in specific regions.	CL3
CO4	Apply the principles of non-conventional energy conversion to analyze the working and applications of geothermal, biomass, and hydrogen energy systems.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	1			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	1			1	1	1				1			3

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses– Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 3rd ed., New Delhi: Tata McGraw-Hill, 2008.
2. G. D. Rai, Non-Conventional Energy Sources, 5th ed., New Delhi: Khanna Publishers, 2011.
3. P. K. Nag, Power Plant Engineering, 4th ed., New Delhi: McGraw Hill Education, 2017.
4. S. Arora and S. Domkundwar, Power Plant Engineering, 6th ed., New Delhi: Dhanpat Rai & Co. Pvt. Ltd., Reprint 2022.
5. B. H. Khan, Non-Conventional Energy Resources, 4th ed., New Delhi: McGraw Hill Education, 2017.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://onlinecourses.nptel.ac.in/noc21_ge04/preview

HYBRID AND ELECTRIC VEHICLES
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BME605Q2**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Automotive Engineering, Mechanical Engineering and Basic electrical and electronics engineering.

COURSE OBJECTIVES:

- Select an appropriate drive strategy for the creation of an electric hybrid vehicle based on available resources.
- Create and formulate fundamental designs for electric vehicles and hybrid electric vehicles.
- Select suitable energy storage systems for use in vehicle applications.
- Recognize different communication protocols and technologies employed in automotive networks.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction of Electric Vehicles: Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs. Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. **HEV:** Configuration of HEV (Series, Parallel, Series-parallel & Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system performance.	**10 Hours**

MODULE - II

Energy Sources: Different Batteries, Battery characteristics (Discharging &Charging) **Battery Chargers:** Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and charge zone. EV and EV charging standards, V2G, G2V, V2B, V2H.	**10 Hours**

MODULE - III

DC Motor: Type of wound-field DC Motor, Torque speed characteristics, DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed DC motor drive, speed control of DC Motor. **Induction Motor Drive:** Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control	**10 Hours**

MODULE - IV

Electric vehicle drive train: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. **Hybrid electric drive-trains:** Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis **Sizing the drive system:** the propulsion motor, sizing the power electronics, selecting the energy storage technology.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the evolution, key technologies, and configurations of electric and hybrid electric vehicles	CL3
CO2	Interpret the characteristics of different batteries, types of charging methods, and the structure of EV charging infrastructure along with related standards and technologies	CL3
CO3	Describe the operating principles and control methods of DC and induction motor drives used in electric vehicle applications.	CL3
CO4	Understand the structure and operation of electric and hybrid drive train topologies and the considerations involved in sizing motors, power electronics, and energy storage systems.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40 %	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Modern Electric Vehicle Technology" by C.C Chan, K.T Chau, Oxford University Press Inc., New York 2001
2. "Electric and Hybrid Vehicles: Design Fundamentals," by CRC Press, 2003.
3. "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design" by Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 2004
4. "Electric Vehicle Battery Systems" by Sandeep Dhameja, Newnes, 2000
5. "Hybrid Vehicles and the Future of Personal Transportation" by A. E. Fuhs, CRC Press, 2009.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://nptel.ac.in/courses/108103009
2. https://www.youtube.com/watch?v=rK6Bey_loiw

INTRODUCTION TO AUTOMOBILE ENGINEERING

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	**BME605Q3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Mathematics, Data Structures.

COURSE OBJECTIVES:

- To understand the different chassis design & main components of an engine
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Engine Components: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.

Cooling and Lubrication: Cooling requirements, Types of cooling- Thermo siphon system, forced circulation water cooling system, water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

10 Hours

MODULE - II

Transmission Systems: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

Brakes: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock, & Numerical.

10 Hours

MODULE - III

Steering And Suspension Systems: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

Ignition System: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

10 Hours

MODULE - IV

Superchargers And Turbochargers: Types of superchargers, Turbocharger construction details. **Automotive Emission Control Systems:** Different air pollutants. Automotive emission controls, controlling crankcase emissions, Cleaning the exhaust gas, Exhaust gas recirculation, Treating the exhaust gas, Catalytic converter, Bharat Stage VI norms. Motor Vehicle Act. **Structure and Function of ECUs:** ECU architecture (input, processing, output), Types of ECUs: Powertrain, Body, Chassis, Interaction with mechanical components, Sensors: TPS, MAP, MAF, O2, Knock, Crankshaft Position	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify the different parts of an automobile and it's working.	CL3
CO2	Understand the working of transmission and braking systems.	CL3
CO3	Understand the working of steering and suspension systems and their applications.	CL3
CO4	Analyze the cause of automobile emissions, its effects on environment and methods to reduce the emissions.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	1				2				2		
CO2	3	3	2					2				2		
CO3	3	3	3					2				2		
CO4	3	3	3					2				2		
CO5	3	3	3					2				2		

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII

		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

TEXT BOOKS:

1. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011
2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2nd Edition

REFERENCE BOOKS:

1. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2007
2. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc
3. Automobile Engineering R. B. Gupta Satya Prakashan 4th edition 1984.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

INTRODUCTION TO COMPUTER INTEGRATED MANUFACTURING

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BME605Q4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Manufacturing Operations, Basics of Computers.

COURSE OBJECTIVES:

- To apply the principles of automation and Computer Integrated Manufacturing (CIM) to calculate production parameters and interpret mathematical models in manufacturing systems.
- To construct two-dimensional geometric models and perform transformations using computer graphics and Computer-Aided Design (CAD) software.
- To develop CNC part programs using G-codes, M-codes, and canned cycles for various machining operations such as turning, drilling, and milling.
- To demonstrate the configuration, control, and programming methods of industrial robots for executing basic manufacturing tasks.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Introduction to CIM and Automation: Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating, Computer Integrated Manufacturing, computerized elements of a CIM system, CAD/CAM and CIM. Mathematical models and matrices: production rate, production capacity, utilization and availability, manufacturing lead time, work-in- process, numerical problems.	**10 Hours**

MODULE – II

CAD and Computer Graphics Software: The design process, applications of computers in design**,** software configuration, functions of graphics package, constructing the geometry. Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations.	**10 Hours**

MODULE – III

Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles. Cutter radius compensations.	**10 Hours**

MODULE – IV

Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and offline methods. Robot industrial applications: material handling, processing and assembly and inspection.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the principles of automation and CIM to calculate production parameters and interpret mathematical models in manufacturing.	CL3
CO2	Construct 2D geometric models and perform transformations using computer graphics and CAD tools.	CL3
CO3	Develop CNC part programs using G-codes, M-codes, and canned cycles for turning, drilling, and milling operations.	CL3
CO4	Demonstrate the configuration and programming methods of industrial robots for basic manufacturing applications.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	1				2				2		2	
CO2	3	3	2					2				2		2	
CO3	3	3	3					2				2		2	
CO4	3	3	3					2				2		2	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII
		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02

3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Automation, Production Systems and Computer-Integrated Manufacturing, Mikell P Groover, Pearson Learning, 4th edition, 2015.
2. CAD / CAM Principles and Applications, P N Rao, Tata McGraw-Hill, 3rd Edition 2015.
3. CAD / CAM Principles and Applications, P N Rao, Tata McGraw-Hill, 3rd Edition.
4. Principles of Computer Integrated Manufacturing, S Kant Vajapayee, Prentice Hall of India, 1999.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. **https://www.youtube.com/watch?v=49RET0NITY&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS**
2. **https://www.youtube.com/watch?v=eFU7tSld7Yc&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS&index=2**

Additive Manufacturing Lab

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BME607L**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of Rapid Prototyping.

COURSE OBJECTIVES:

- Develop the prototype using 3D printing or Additive Manufacturing (AM) machine.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Sl. No.	Description
1	Introduction to 3D Printing and Safety: Overview of 3D printing technologies, Safety precautions in the 3D printing lab, Introduction to lab equipment and software.
2	FDM calibration and Printer setup: Calibrating the FDM printer, Setting up the print bed, Printing a basic FDM object.
3	Designing for FDM: Introduction to CAD software (e.g., Tinkercad, Fusion 360), Designing a simple FDM object, Exporting and preparing the design for printing
4	Advanced FDM Printing: Printing complex geometries with FDM, Understanding support structures, Post-processing techniques for FDM prints
5	FDM Material Exploration: Exploring different FDM materials (PLA, ABS, PETG, etc.), Comparing material properties, Printing with specialized filaments (flexible, composite, etc.)
6	SLA Printer Setup and Calibration: Calibrating the SLA printer, Handling resin materials, Printing a basic SLA object.
7	Designing for SLA: Design considerations for SLA printing, Creating supports for SLA objects, Exporting and preparing a design for SLA printing.
8	SLA Post-Processing Techniques: Cleaning and curing SLA prints, Surface finishing techniques (sanding, painting, etc.), Assembling complex SLA-printed parts
9	SLA Material Exploration: Exploring different SLA resin materials (standard, flexible, castable, etc.), Understanding material properties and applications.
10	Creating intricate and functional designs.

11	Troubleshooting and Maintenance: Common 3D printing issues and solutions, Routine maintenance of FDM and SLA printers. Final project consultation and troubleshooting.
12	Students will work on individual or group projects using both FDM and SLA printers, Presentation of final projects and portfolio, Course review, Q&A, and future prospects in 3D printing.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the operations of FDM and SLA 3D printers, and also their respective mechanisms, software interfaces, and calibration processes to produce precise and accurate prints.	CL3
CO2	Create and modify 3D models optimized for FDM and SLA printing, applying design principles to ensure structural integrity and appropriate resolution for different applications.	CL3
CO3	Acquire troubleshooting skills to diagnose and address common printing issues, as well as the ability to fine-tune print parameters to enhance efficiency, print quality, and material usage.	CL3
CO4	Analyze the properties and behaviors of various printing materials used in FDM and SLA technologies, as well as the post-processing techniques necessary to refine and finish printed objects.	CL3
CO5	Explore innovative applications of 3D printing, experimenting with complex geometries, multi-material prints, and design enhancements to expand their understanding of the technology's potential in various industries.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2			2							2	2	2	2
CO2	3	2	2		2							2	2	2	
CO3	3	2	2		2							2	2	2	2
CO4	3	2			2							2		2	2
CO5	3	2	2		2							2	2	2	2
3: Substantial (High)					**2: Moderate (Medium)**					**1: Poor (Low)**					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).

Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).

Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).

- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

1. All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
2. SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
3. General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
4. Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

1. https://3dp-dei.vlabs.ac.in/
2. https://nptel.ac.in/courses/112103306
3. https://3dp-dei.vlabs.ac.in/exp/simulation-stereolithography-process/
4. https://3dp-dei.vlabs.ac.in/exp/simulation-modelling-process/
5. https://3dp-dei.vlabs.ac.in/exp/simulation-laser-sintering-nonmetal/
6. https://3dp-dei.vlabs.ac.in/exp/simulation-laser-sintering-metal/
7. https://3dp-dei.vlabs.ac.in/exp/simulation-post-processing/
8. https://3dp-dei.vlabs.ac.in/exp/simulation-additive-manufacturing/

DESIGN OF EXPERIMENTS LAB
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BME608A1**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of Mechanics of Materials, Theory of Machines.

COURSE OBJECTIVES:

-

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Introduction to Design of Experiments.
2	Introduction to Optimization.
3	Introduction to MATLAB.
4	Full Factorial Design using DATA tab software.
5	Fractional Factorial design using DATA tab software.
6	Classical Optimization Techniques.
7	Unconstrained Optimization: Elimination Methods.
8	Unconstrained Optimization: Interpolation Method.
9	Unconstrained Optimization: Direct Root Methods.
10	Constrained Optimization: Equality Constraints.
11	Constrained Optimization: Inequality Constraints.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Demonstrate a foundational understanding of optimization techniques.	CL4
CO2	Develop proficiency in using computational tools for optimization and Factorial design.	CL4
CO3	Apply classical optimization methods to solve practical problems.	CL4
CO4	Solve constrained optimization problems using systematic approaches.	CL4

CO5	Analyze and evaluate optimization solutions for engineering applications.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2									2	3		
CO2	2	2	2									2	3		
CO3	2	2	2									2	3		
CO4	2	2	2									2	3		
CO5	2	2	2									2	3		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. "Optimization for Engineering Design: Algorithms and Examples" by Kalyanmoy Deb.
2. Engineering Optimization: Theory and Practice by S.S. Rao.
3. Introduction to Optimization by Edwin K. P. Chong and Stanislaw H. Żak.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. https://www.youtube.com/watch?v=4qF1kaGZfbg

COMPUTATIONAL FLUID DYNAMICS LAB
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	BME608A2	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Fluid Mechanics
- Heat Transfer
- Numerical Methods

COURSE OBJECTIVES:

- To provide fundamental understanding of the governing equations of fluid flow and their numerical solutions.
- To develop competency in discretization techniques and stability analysis for solving fluid dynamics problems.
- To enable hands-on experience using CFD software tools for solving real-life engineering applications.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Grid Generation for a 2D geometry (airfoil or pipe)
2	Laminar Flow Simulation in a 2D channel
3	Steady-State Heat Conduction in a solid plate
4	Unsteady Heat Conduction in a 1D rod
5	Flow Over a Cylinder – Pressure and velocity profile
6	Conjugate Heat Transfer in a heat exchanger model
7	Natural Convection in an enclosed cavity
8	Turbulent Flow Simulation using k-ε model
9	Boundary Layer Analysis over a flat plate
10	CFD Simulation of a Centrifugal Pump or Fan (post-processing of velocity vectors and contours)

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the physical meaning and mathematical formulation of governing equations in fluid dynamics.	CL 2

CO2	Apply finite difference, finite volume, and finite element methods for solving CFD problems.	CL 3
CO3	Analyze stability, convergence, and consistency of numerical schemes.	CL 4
CO4	Solve heat and fluid flow problems using commercial/open-source CFD software.	CL 3
CO5	Validate and interpret CFD simulation results in comparison with experimental or analytical data.	CL 5

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2										2			3
CO2	3	2	2		2							2			3
CO3	3	3		2	1							2			3
CO4	2	2	3	2	3				1			2			3
CO5	2	3	2	3	2				1	2		2			3
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.

- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Patankar, Suhas. Numerical heat transfer and fluid flow. CRC press, 2018.
2. Anderson, John David, Gérard Degrez, Erik Dick, and Roger Grundmann. Computational fluid dynamics: an introduction. Springer Science & Business Media, 2013.
3. Tu, Jiyuan, Guan Heng Yeoh, Chaoqun Liu, and Yao Tao. Computational fluid dynamics: a practical approach. Elsevier, 2023.
4. Anderson, Dale, John C. Tannehill, Richard H. Pletcher, Ramakanth Munipalli, and Vijaya Shankar. Computational fluid mechanics and heat transfer. CRC press, 2020.
5. Versteeg, H. K., and W. Malalasekera. "Computational fluid dynamics." The finite volume method (1995): 1-26.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

1. NPTEL: https://youtu.be/aShONtHloUk?si=5pAIfg-wCJNbogQ5
2. NPTEL: https://youtu.be/3QFT7pGx03I?si=AVplNTNUJwmPiJ8-
3. NPTEL: https://youtu.be/sfLkKJthQ2g?si=nzItmasn-sh43AtY

Metal Joining and Testing Lab

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BME608A3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

COURSE OBJECTIVES:

- **To provide practical knowledge of various metal joining techniques including welding, brazing, and soldering.**
- **To understand and apply destructive and non-destructive testing methods for evaluating joint quality.**
- **To develop hands-on skills in handling metal joining equipment and safety procedures.**
- **To correlate the mechanical properties of joints with the process parameters and material characteristics**

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Manual Metal Arc Welding (MMAW): Bead-on-Plate Welding Practice: Understand arc initiation, control, and basic weld bead formation.
2	Gas Welding (Oxy-Acetylene Welding): Perform gas welding on mild steel plates and examine joint quality.
3	TIG Welding of Stainless Steel: Understand the working principle of TIG welding and produce clean joints
4	MIG Welding of Mild Steel: Practice MIG welding and analyze ease of automation and deposition rate
5	Brazing of Dissimilar Metals (Copper and Steel): Perform brazing and study the microstructure of the joint under a microscope.
6	Soldering of Electrical Components and Thin Metal Sheets: Use soft soldering techniques for joining small components and study joint quality.
7	Tensile Testing of Welded Joints: ⌄ Perform tensile test on welded specimens and evaluate mechanical properties.
8	Bend Test for Welded Plates: Conduct bend test to assess ductility and surface defect occurrence in welded joints.
9	Non-Destructive Testing – Dye Penetrant Test (DPT): Detect surface cracks or porosity in welds using DPT technique.

10	Non-Destructive Testing – Ultrasonic Testing (UT): Understand principles of ultrasonic testing and inspect internal flaws in welded specimens.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Demonstrate the ability to perform basic metal joining processes such as arc welding, gas welding, brazing, and soldering	CL 3
CO2	Apply appropriate testing methods (NDT and DT) to evaluate the strength and integrity of joints.	CL 3
CO3	Interpret test results to assess quality and suitability of joints for various applications.	CL 4
CO4	Follow industrial safety protocols and proper handling of metal joining equipment.	CL 4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	3		2					2		1		3	
CO2	3	2	3		2					2		1		3	
CO3	3	2	3		2					2		1		3	
CO4	3	2	3		2					2		1		3	
CO5	3	2	3		2					2		1		3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

   a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

   b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

   c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

- **Welding Technology"** by O. P. Khanna
- **"A Textbook of Welding Technology"** by R. S. Parmar
- **"Non-Destructive Testing"** by B. Raj, T. Jayakumar, and M. Thavasimuthu
- **"Materials Science and Testing"** by M. S. Vijaya and G. Rangarajan

IIoT Lab
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BME608A4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:1	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Fundamental knowledge of IoT.

COURSE OBJECTIVES:

- Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
- Explore IoT technologies, architectures, standards, and regulation
- Realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices
- Examine technological developments that will likely shape the industrial landscape in the future
- Understand how to develop and implement own IoT technologies, solutions, and applications

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

LIST OF EXPERIMENTS

Exp. No.	Description
1	Introduction and Architecture to IoT & IIoT
2	Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using IoT kits
3	Measurement of Temperature and Pressure using IoT kit
4	Demonstration of MQTT Communication
5	Demonstration of LoRa communication.
6	Visualization of Diverse Sensors data using Dashboard.
7	Device Control using mobile Apps or through Web pages.
8	Machine to Machine communication.
9	Using an IOT device establishes the connection between two devices.
10	Logic Gate Simulation

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level

CO1	Apply IoT and IIoT architectural concepts to develop basic sensor-based systems using appropriate communication protocols and interfacing techniques.	CL3
CO2	Implement sensor interfacing techniques to measure parameters like temperature, pressure, and moisture using IoT development kits effectively.	CL3
CO3	Demonstrate communication between IoT devices using MQTT and LoRa protocols for reliable data transmission in industrial and smart applications.	CL3
CO4	Develop dashboards to visualize real-time sensor data and perform device control through mobile applications or web interfaces.	CL3
CO5	Simulate logic gates and establish machine-to-machine communication using IoT devices for basic automation and control operations.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2			3							2		2	2
CO2	3	2			3							2		2	2
CO3	3	2			3							2		2	2
CO4	3	2			3							2		2	2
CO5	3	2			3							2		2	2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

i. In Laboratory Courses where component (C) is not a component of the assessment pattern, then component (A) will have 50% weightage (25 Marks), and component (B) will have 50% weightage (25 Marks). In such cases,

   a) The average marks obtained across all the laboratory sessions (each laboratory session shall be evaluated for 25 marks) shall be the marks for component (A).

   b) One or two laboratory tests [component (B)] similar to the SEE shall be conducted and the marks shall be scaled down to 25 marks.

   c) The CIA marks for the laboratory shall be the sum of marks obtained for the component (A) and component (B).

ii. The course instructor will design the rubrics for component (C).

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.

- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
2. Industrial Internet of Things: Cybermanufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
3. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if Any):

CONTROL ENGINEERING
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BME701G**	CIA Marks	50
Number of Contact Hours/Week(L:T:P:S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L+ 20P	Exam Hours	03

CREDITS–4

COURSE PREREQUISITES:

- Basic knowledge of Electrical and Electronic Circuits, and Physics Concepts

COURSE OBJECTIVES:

- To acquire a thorough grasp of contemporary control theory, industrial automation, and systems analysis.
- To create models for mechanical, hydraulic, pneumatic, and electrical systems.
- To represent system elements by blocks and their reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyze a system using root locus plots.
- To understand the principles and components of data acquisition systems and virtual instrumentation.

TEACHING-LEARNING STRATEGY:

FollowingaresomesamplestrategiesthatcanbeincorporatefortheCourseDelivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the course contents

COURSECONTENTS

MODULE-I	
Introduction: Components of a control system, open-loop and closed-loop systems. Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral- Differential controllers. **Modelling of Physical Systems:** Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems	**10 Hours**
MODULE-II	
Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first-order, second-order system. Steady state error, error constants. **Block diagram algebra:** Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.	**10 Hours**
MODULE-III	

Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain margin using root locus. **Stability analysis** using Polar plot, Nyquist plot, Bode plot.	**10 Hours**

MODULE-IV

Data Acquisition Systems: A/D and D/A converters, Plug-in Analog Input / Output cards – Digital Input and Output Cards, Opto-isolation – Performing analog input and analog output – Scanning multiple analog channels – Issues involved in selection of Data acquisition cards – Data acquisition modules with serial communication. **Virtual Instrumentation:** Block diagram and Architecture for Virtual Instruments versus Traditional Instruments Instrumentation -VI Programming techniques - VI, sub VI, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output	**10 Hours**

COURSEOUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Distinguish the open and closed type of controllers and time domain control systems.	CL3
CO2	Analyze the control systems with the aid of block diagram reduction, signal flow graphs, and frequency response diagrams.	CL3
CO3	Analyze the stability of control systems with the aid of Root locus, Polar plot, Nyquist plot and Bode plot.	CL3
CO4	Organize the DAQ systems and analyze the Virtual instrumentation using in VI software.	CL3

LABORATORYCOMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	To simulate and understand the components of a control system, and compare open-loop vs closed-loop behavior using Scilab.	CO1	CL3
2.	Demonstration of the dynamic behaviour of the mechanical system	CO1	CL3
3.	Demonstrate the effect of different types of controllers on a second-order plant using Scilab.	CO1	CL3
4.	Demonstrate the simulate the response of a mass-spring-damper system using Scilab.	CO1	CL3
5.	Demonstration and hand-on exercise on time domain specification using Scilab/Python	CO2	CL3
6.	Demonstration to determine the steady-state error and error constants (position, velocity, and acceleration) using Scilab.	CO2	CL3
7.	Demonstration of constructing of Routh's array using Scilab-Xcos/OpenModelica/other system modelling software.	CO3	CL3
8.	Demonstration of Graphical modelling of root locus using Scilab-Xcos/OpenModelica/other system modelling software.	CO3	CL2
9.	To perform basic arithmetic operations such as addition, subtraction, multiplication, and division using numeric functions.	CO4	CL3
10.	To implement logical operations like AND, OR, NOT, and XOR for decision-making in digital systems.	CO4	CL3

CO-PO-PSOMAPPING

CO No.	Programme Outcomes(PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	3							1		1	2		
CO2	3	3	3							1		1	2		
CO3	3	3	3	1	2				1	1		1	2		
CO4	3	3	3	1	2				1	1		1	2		
3:Substantial(High)					2:Moderate (Medium)					1:Poor(Low)					

ASSESSMENTSTRATEGY

Assessment will be both CIA and SEE.StudentslearningwillbeassessedusingDirectandIndirectmethods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	30 %	15
	Practical Session (Laboratory Component)	20 %	10
	Laboratory Continuous Assessment	30 %	15
	Laboratory Test (After the completion of all experiments*)	20 %	10
2	**Semester End Examination(SEE)**	**100 %**	**50**

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Control Engineering, U.A. Bakshi & V.U. Bakshi, Technical Publications, 2021
2. Modern Control Engineering, K. Ogata, Pearson Education India, 2015
3. A Course in Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai & Co. (P) Limited
4. Electronic Measurements and Instrumentation, Ajay V Bakshi, Uday A Bakshi, Technical Publications, 2020
5. Virtual Instrumentation using LABVIEW, Sanjay Gupta, McGraw Hill, 2017

REFERENCE WEBLINKS AND VIDEO LECTURES (E-RESOURCES) (If Any):

1. https://onlinecourses.nptel.ac.in/noc20_me94/preview
2. https://www.youtube.com/watch?v=KBy3ISlCES4&list=PLgwJf8NK-2e43et6qbo4IqYSJCv-6kN90
3. https://www.youtube.com/playlist?list=PLB968815D7BB78F9

DESIGN OF MACHINE ELEMENTS II
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	BME702T	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Engineering Mechanics, Mechanics of Materials, Engineering Machine Drawing.

COURSE OBJECTIVES:

- To understand the design formulation of springs and bearings.
- To understand the design formulation of spur, helical, bevel and worm gears.
- To understand the design formulation of clutches, brakes, belts and wire ropes.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Concentric springs; springs under fluctuating loads. **Leaf Springs**: Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Belleville springs. **Journal bearings:** Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated. Numerical examples on journal bearing.	**10 Hours**

MODULE - II

Spur Gears: Definitions, stresses in gear tooth, Lewis equation and form factor, design for strength, dynamic load and wear. **Worm Gears:** Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	**10 Hours**

MODULE - III

Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear. **Bevel Gears:** Definitions, formative number of teeth, design based on strength, dynamic load and wear.	**10 Hours**

MODULE - IV

Design of Clutches: Necessity of a clutch in automobile, types of clutches, friction materials and its properties. Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories. **Design of Brakes**: Different types of brakes, Concept of self-energizing and self-locking of brakes. Design of band brakes, block brakes. **Belts:** Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts-	**10 Hours**

length & cross section. **Wire ropes:** Construction of wire ropes, stresses in wire ropes, and selection of wire ropes.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the performance of various types of springs and journal bearings by evaluating stresses under various loading conditions.	CL4
CO2	Analyze the design of spur and worm gears by evaluating material selection, and load conditions using strength, dynamic, and wear considerations.	CL4
CO3	Analyze the design of helical and bevel gears by evaluating material selection, and load conditions using strength, dynamic, and wear considerations.	CL4
CO4	Analyze the design formulations of clutches, brakes, belts, and wire ropes.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1		2			1	1	1		2	2		
CO2	3	2	1		2			1	1	1		2	2		
CO3	3	2	1		2			1	1	1		2	2		
CO4	3	2	1					1	1	1		2	2		

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05

4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totaling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Shigley's Mechanical Engineering Design" by Richard G. Budynas, and J. Keith Nisbett, McGraw-Hill Education, 11th edition, 2020.
2. "Design of Machine Elements" by V B Bhandari, Tata McGraw Hill, 5th edition, 2020.
3. "Machine Design" by Robert L. Norton, Pearson Education, 5th Edition, 2018.
4. "Design of Machine Elements" by Dr. M H Annaiah Dr. J Suresh Kumar, New Age International, 1st Edition, 2016.
5. "Elements of Machine Design" by H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil, IK International, First Edition, 2019.

DESIGN DATA HAND BOOK:

1. Design Data Hand Book by K. Mahadevan and Balaveera Reddy, CBS Publication, 4th Revised edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. Design of Machine Elements https://nptel.ac.in/courses/112/105/112105125/
2. Design of Machine Elements https://nptel.ac.in/courses/112/105/112105124/
3. Design of Machine Elements https://nptel.ac.in/courses/112/106/112106137/

OPERATIONS AND SUPPLY CHAIN MANAGEMENT
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	BME703E1	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Management and Mathematics.

COURSE OBJECTIVES:

- To introduce the fundamentals of production and operations management and decision-making models.
- To familiarize students with forecasting methods for operational planning.
- To provide insights into capacity, location, layout, and aggregate planning techniques.
- To explain material requirement planning and supply chain management practices.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Production and Operations Management: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity. **Decision Making:** The decision process, characteristics of operations decisions, use of models - B.E.P, decision making environments. Decision trees.	**10 Hours**

MODULE - II

Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, Regression and Correlation methods, accuracy and control of forecasts, Choosing a forecasting technique, Elements of a good forecast.	**10 Hours**

MODULE - III

Capacity, Location and Layout Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives. Design, System actual capacity. System efficiency and utilization. Determination of Equipment requirements for a single-stage production process. Numerical problems on the above. Need for location decisions, nature of location decisions, general procedure for making location decisions, and evaluating location decisions. Facilities layout - Need for layout decisions. Minimizing material handling cost in process layout using Load distance analysis, and Simple line balancing problems in product layouts. **Aggregate Planning & Master Scheduling**: Aggregate planning - Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning -Mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.	**10 Hours**

MODULE - IV

Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP - MRP inputs and outputs, JIT manufacturing, Kanban System and ERP, benefits and limitations of MRP. Capacity requirement planning. **Purchasing and Supply Chain Management (SCM):** Introduction, Importance of purchasing and	**10 Hours**

SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the functions of operations management and evaluate decision-making models such as BEP, transportation models, and decision trees to improve productivity and efficiency in business operations.	CL3
CO2	Apply forecasting techniques including time series analysis, regression, and judgment-based methods to develop accurate and effective forecasts for operational planning	CL3
CO3	Design and evaluate capacity, location, and layout planning strategies, including aggregate planning and master scheduling, using quantitative tools such as load-distance analysis and line balancing.	CL3
CO4	Implement material planning and supply chain strategies using tools such as MRP, JIT, and ERP, and assess procurement and vendor development processes for efficient resource management.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2										2		2	
CO2	3	2										2		2	
CO3	3	2										2		2	
CO4	3	2										2		2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Production and Operation Management Chary S. N. TataMcGrew Hill 3rd edition.
2. Production and Operations Management, Everett E. Adams, Ronald J. Ebert, Prentice Hall of India Publications, Fourth Edition.
3. Modern Production/Operations Management, Buffia, Wiely India Ltd 4th Edition.
4. Operation Management, Author- Joseph G Monks McGrew Hill Publication, International Edition-1987.
5. Production and Operation Management", Author-Pannerselvam R. PHI publications, 2nd edition
6. An Introductory book on lean System, TPS Yasuhiro Modern.
7. Operations Management, William J Stevenson, TataMcGrew Hill 13th edition.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. **https://onlinecourses.nptel.ac.in/noc20_me30/preview**

AUTOMOTIVE ENGINEERING

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	**BME703E2**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Mathematics, Data Structures.

COURSE OBJECTIVES:

- To understand the different chassis design & main components of an engine
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

Engine Components: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S.I. Engine and C.I. Engines, methods of a Swirl generation, engine positioning. Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car.

Cooling and Lubrication: Cooling requirements, Types of cooling- Thermo siphon system, forced circulation water cooling system, water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

10 Hours

MODULE - II

Transmission Systems: Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

Brakes: Types of brakes, mechanical compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock – Braking systems, purpose and operation of antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock, & Numerical.

10 Hours

MODULE - III

Steering And Suspension Systems: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system.

Ignition System: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

10 Hours

MODULE - IV

Superchargers And Turbochargers: Types of superchargers, Turbocharger construction details. **Automotive Emission Control Systems:** Different air pollutants. Automotive emission controls, controlling crankcase emissions, Cleaning the exhaust gas, Exhaust gas recirculation, Treating the exhaust gas, Catalytic converter, Bharat Stage VI norms. Motor Vehicle Act. **Structure and Function of ECUs:** ECU architecture (input, processing, output), Types of ECUs: Powertrain, Body, Chassis, Interaction with mechanical components, Sensors: TPS, MAP, MAF, O2, Knock, Crankshaft Position	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify the different parts of an automobile and it's working.	CL3
CO2	Understand the working of transmission and braking systems.	CL3
CO3	Understand the working of steering and suspension systems and their applications.	CL3
CO4	Analyze the cause of automobile emissions, its effects on environment and methods to reduce the emissions.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2	1				2				2		
CO2	3	3	2					2				2		
CO3	3	3	3					2				2		
CO4	3	3	3					2				2		
CO5	3	3	3					2				2		

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII		MIII	MIII

		MIV	MIV	MIV
		MV	MV	MV

Note: For Examinations (both CIE and SEE), the question papers shall contain the questions mapped to the appropriate Bloom's Level. Any COs mapped with higher cognitive Bloom's Level may also be assessed through the assignments.

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have **TEN** full questions from **FIVE** Modules
- There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
- Each full question may have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting one full question from each module.

TEXT BOOKS:

1. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011
2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2nd Edition

REFERENCE BOOKS:

1. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2007
2. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc
3. Automobile Engineering R. B. Gupta Satya Prakashan 4th edition 1984.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

ROCKET PROPULSION
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BME703E3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fluid Mechanics
- Thermodynamics
- Heat transfer

COURSE OBJECTIVES:

- To provide students with a thorough understanding of the principles and physical laws governing rocket propulsion systems, including the mechanics of thrust generation and propulsion efficiency.
- To familiarize students with various propulsion technologies, including liquid, solid, hybrid, and advanced systems, and their applications in space exploration and defense.
- To enable students to analyze and design key components of rocket propulsion systems, such as nozzles, combustion chambers, and propellants, and to evaluate their performance under various operating conditions.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I	
Introduction: Classification of power plants, Methods of aircraft propulsion, Propulsive efficiency, Specific fuel consumption, Thrust and power, Factors affecting thrust and power. **Illustration of working of Gas turbine engine**: Characteristics of turboprop, turbofan and turbojet, Ram jet, Scramjet, Methods of Thrust augmentation. **Fundamentals and Definitions:** Thrust, Exhaust Velocity, Energy and efficiencies, multiple propulsion systems, typical performance values, variable thrust and simple problems.	**10 Hours**
MODULE - II	
Rocket propulsion: Classification and applications of rockets, Reaction principle, Thrust equation, Classification of rockets based on propellants used, solid, liquid and hybrid, Comparison of these engines with special reference to rocket performance, electric propulsion, classification: electro thermal – electrostatic – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.	**10 Hours**
MODULE - III	
Nozzle Theory and Thermodynamics Relations: review of thermodynamics relations, ideal rocket propulsion systems, isentropic flow through nozzles, nozzle configuration, real nozzles, nozzle alignment, over expanded, under expanded nozzles and optimum expansion in nozzles **Thrust Chambers:** Injectors, flow characteristics, factors influencing injection behavior, heat transfer analysis, starting and ignition, life of thrust chambers, random variable thrust, sample thrust chamber design analysis, Thrust Vector Control with single nozzle and multiple nozzles. Integration with vehicles.	**10 Hours**
MODULE - IV	
Solid Propellant Rocket engine: Basic relations and propellant burning rate, performance issues, propellant grain and grain configuration, propellant grain stress and strain, altitude control and side man oeuvres with solid propellant rocket motors. **Solid Propellants:** Classification, propellant characteristics, hazards, propellant ingredients, other propellant categories.	**10 Hours**

Liquid Propellant rocket engine: Types of propellants, propellant tanks, propellant feed systems, gas pressure feed systems, tank pressurization, turbopump feed system, rocket engines for maneuvering and orbit adjustments. **Liquid Propellants:** propellant properties, liquid oxidizers, liquid fuels, liquid monopropellants, gaseous propellant, safety and environment concern. Combustion process and instability.	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyze the performance characteristics of various aircraft propulsion systems including turbojet, turbofan, turboprop, and ramjet engines with respect to thrust, specific fuel consumption, and propulsive efficiency.	CL4
CO2	Analyze different rocket propulsion systems including solid, liquid, and hybrid engines, and compare their design and performance characteristics for specific mission profiles.	CL4
CO3	Analyze isentropic flow through various nozzle configurations, and examine the influence of expansion conditions and nozzle alignment on thrust production and chamber performance.	CL4
CO4	Analyze the behavior of solid and liquid propellant rocket engines based on propellant characteristics, grain configuration, feed systems, and combustion stability for effective thrust generation.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1			1	1	1				1			3
CO2	3	3	1			1	1	1				1			3
CO3	3	3	1			1	1	1				1			3
CO4	3	3	1			1	1	1				1			3

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks

1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses– Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. G. P. Sutton and O. Biblarz, Rocket Propulsion Elements, 9th ed., Hoboken, NJ: Wiley, 2016.
2. H. Cohen, G. F. C. Rogers, and H. I. H. Saravanamuttoo, Gas Turbine Theory, 6th ed., Harlow, UK: Pearson Education, 2009.
3. J. R. Church, Introduction to Rocket Propulsion, New Delhi: CreateSpace Independent Publishing Platform, 2018.
4. M. J. L. Turner, Rocket and Spacecraft Propulsion: Principles, Practice and New Developments, 3rd ed., Cham: Springer, 2017.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://archive.nptel.ac.in/courses/101/104/101104078/

NANOTECHNOLOGY

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	**BME703E4**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- course on "Programming for Problem Solving using C

COURSE OBJECTIVES:

- Understand the Object-Oriented Programming concepts using the C++ language.
- Understand the principles of data abstraction, inheritance and polymorphism.
- Understand the principles of virtual functions and polymorphism.
- Understand the concept of handling formatted I/O and unformatted I/O.
- Understand the concepts of exception handling.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to Nanoscience and Nanotechnology: Historical background and evolution, Nanoscale phenomena: quantum effects and surface-to-volume ratio, Size and scale comparison (macro, micro, nano), Overview of nanomaterials and their classifications	**10 Hours**

MODULE - II

Synthesis and Fabrication Techniques: Top-down vs. bottom-up approaches**,** Physical and chemical vapor deposition**,** Sol-gel, ball milling, and laser ablation**,** Lithography techniques (photolithography, e-beam)	**10 Hours**

MODULE - III

Characterization Techniques: Scanning Electron Microscopy (SEM)**,** Transmission Electron Microscopy (TEM)**,** Atomic Force Microscopy (AFM)**,** X-ray Diffraction (XRD) and Spectroscopy techniques	**10 Hours**

MODULE - IV

Applications and Implications in Mechanical Engineering : Nanomaterials in composites and coatings**,** Nanotechnology in manufacturing (MEMS/NEMS)**,** Thermal conductivity at nanoscale Environmental, health, safety, and ethical issues	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Explain the fundamental principles and scope of nanotechnology, and describe its significance in mechanical engineering	CL2

CO2	Summarize the key synthesis and fabrication methods used for creating nanomaterials using both top-down and bottom-up approaches.	CL2
CO3	Interpret the basic working principles of major nanomaterial characterization tools and explain how they are used to analyze material properties.	CL2
CO4	Discuss various mechanical engineering applications of nanotechnology and describe the associated environmental and ethical considerations.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2									2		2	
CO2	3	2	2									2		2	
CO3	3	2	2									2		2	
CO4	3	2	2									2		2	

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

Introduction to Nanotechnology" – Charles P. Poole Jr. and Frank J. Owens
"Nanotechnology: Principles and Practices" – Sulabha K. Kulkarni
"Nanoscale Science and Technology" – Robert Kelsall, Ian Hamley, and Mark Geoghegan
"Nanotechnology for Mechanical and Biomedical Engineers" – Mark J. Jackson

REFERENCE WEB LINKS AND VIDEO LECTURES (E – RESOURCES):

ENERGY AND ENVIRONMENT

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	BME704Q1	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Environment Science and Biology.

COURSE OBJECTIVES:

- To understand the fundamentals of energy sources, energy use, energy efficiency, and resulting environmental implications of various energy supplies.
- To introduce various aspects of environmental pollution and its control.
- To understand the causes and remedies related to social issues like global warming, ozone layer depletion, climate change etc.
- To introduce various acts related to prevention and control of pollution of water and air, forest protection act, wild life protection act etc.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.	**10 Hours**

MODULE - II

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems. **Energy Management:** Principles of Energy Management, Energy demand estimation, Energy pricing. **Energy Audit:** Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries.	**10 Hours**

MODULE - III

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. **Ecosystem:** Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.	**10 Hours**

MODULE - IV

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards, Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies. **Social Issues and the Environment:** Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply the knowledge of energy sources and consumption patterns to assess India's current energy challenges and propose basic strategies for sustainable energy development.	CL3
CO2	Apply principles of energy management and audit to identify potential areas for energy savings in industrial or commercial processes.	CL3
CO3	Explain the structure and functioning of various ecosystems and the importance of environmental awareness in promoting sustainable development.	CL2
CO4	Explain the causes, effects, and control measures of various types of pollution and analyze key environmental issues and legislation relevant to sustainable business practices.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1			2	3					2			2
CO2	3	3	2	1	2	2	2				1	2			2
CO3	2					2	3	1				1			2
CO4	2	2				2	3	2				2			2

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Textbook for Environmental Studies for Undergraduate Courses of all Branches of Higher Education, University grant commission and Bharathi Vidyapeeth Institute of environment education and Research, Pune.
2. Energy Management Audit & Conservation- for Module 2, Barun Kumar De, Vrinda Publication, 2nd Edition 2010.
3. Energy Management Hand book, Turner, W. C., Doty, S. and Truner, W. C, Fairmont Press, 7th Edition 2009.
4. Energy Management, Murphy, W. R, Elsevier, 2007.
5. Energy Management Principles, Smith, C. B, Pergamum, 2007.
6. Environment pollution control Engineering, C S Rao, New Age International, reprint 2015, 2nd edition.
7. Environmental studies, Benny Joseph, Tata McGraw Hill, 2nd edition 2008.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. NPTEL Video on Energy Resources, Economics and Environment- https://youtu.be/o28OSxpMa8w
2. NPTEL Video on Materials for Energy- https://youtu.be/SCUsVjOHp70
3. NPTEL Video on Biodiversity, population and ecological principles- https://youtu.be/hihFHam_wNE
4. NPTEL Video on Wastewater Recycling: A Sustainable Option for Water Management- https://youtu.be/ BiQiK_hYo
5. NPTEL Video on Sustainable Water Management in Urban Areas- https://youtu.be/ph3JcY8c1Oo

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

BUSINESS PLANNING AND PROJECT MANAGEMENT

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	BME704Q2	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamentals of Management and Mathematics.

COURSE OBJECTIVES:

- To explain the nature, scope, and limitations of planning and forecasting techniques in project environments.
- To introduce key project management concepts, selection models, and organizational structures.
- To develop skills in project scheduling using network analysis tools like PERT and CPM.
- To provide knowledge of project monitoring, control mechanisms, audits, and termination processes.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction: Nature and Limitations of Planning, Planning Devices & Obstacles in Planning and Techniques of Forecasting, Difference between Forecasting and Planning.	**10 Hours**

MODULE - II

Introduction to Project Management: Project Management Maturity, Project Selection - Model & Types, Project Management and Project Manager, Organization Structures for Project Management, Project Organization and Matrix Organization, The Nature of Negotiation, Conflict and PLC.	**10 Hours**

MODULE - III

Network Analysis: Network diagram, basic and important terminologies used in network diagram, PERT and CPM, CPM & Crashing the Project.	**10 Hours**

MODULE - IV

Project Control and termination: The Planning - Monitoring - Controlling Cycle, Fundamental Purposes of Project Control, Design of Control Systems, Some Essentials of an Audit, Varieties of Project Termination, Termination Process.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Distinguish between planning and forecasting, and apply appropriate forecasting techniques in project contexts.	CL2

CO2	Analyze project selection models, organizational structures, and the role of negotiation and conflict in project management.	CL2
CO3	Apply PERT and CPM techniques to schedule, monitor, and optimize project timelines.	CL2
CO4	Evaluate project control systems, audit mechanisms, and termination procedures for effective project closure.	CL2

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1												2	2	2	2
CO2	3	3										2	2	2	2
CO3	3	3										2	2	2	2
CO4	3	3										2	2	2	2

3: Substantial (High)	2: Moderate (Medium)	1: Poor (Low)

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. Project Management: Vasant Desai, Himalaya Publishing House
2. Project Management: A Managerial Approach, Jack R. Meredith, Samuel J. Mantel Jr. Wiley India Pvt. Ltd.
3. Principles of Management: T. Ramasamy, Himalaya Publishing House 8. The McGraw-Hill 36-Hour Project Management Course -McGraw-Hill
4. Production and Operation Management: K. Ashwathappa and Siddharth Bhat, Himalaya Publishing House,2010 editions
5. Project Management: Samule J Mantel, Jr, Jack R. Meredith, Scott M. Shafer, Margaret M, Sutton with M.R. Gopalan, Wiley India Pvt. Ltd.
6. Business Administration with G. M. Dumbre: Success Publications, Pune.
7. Successful Project Management: Milton D. Rosenau, Jr., Cregory D. Githens, Wiley India Pvt. Ltd.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES) (if any):

1. https://onlinecourses.swayam2.ac.in/cec20_mg07/preview

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

PRODUCT DESIGN AND MANUFACTURING
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BME704Q3**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge about manufacturing

COURSE OBJECTIVES:

- Apply product design principles to develop functional and manufactural product concepts based on user requirements.
- Implement manufacturing processes and techniques to produce designed products efficiently and cost-effectively
- Use CAD tools to create detailed product designs and manufacturing drawings for accurate production
- Analyze material selection and manufacturing constraints to optimize product performance and manufacturability.
- Demonstrate process planning by selecting appropriate manufacturing methods for various product components

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to Product Design - Asimow's model: Definition of product design, Design by Evolution, Design by Innovation, Essential Factors of Product design, Production-Consumption Cycle, Flow and Value Addition in the Production-Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and Flowcharting, Role of Allowance, Process Capability and Tolerance in Detailed Design & Assembly.	**08 Hours**

MODULE - II

Product Design Practice and Industry - Introduction, Product Strategies, Time to Market, Analysis of the Product, The S's Standardization, Renard Series, Simplification, Role of Aesthetics in Product Design, Functional Design Practice. **Review of Strength, Stiffness and Rigidity Considerations in Product Design -** Principal Stress Trajectories (Force-Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience Designing for Uniform Strength, Tension vis-a-vis Compression. Review of Production Process: Introduction, Primary Processes, Machining Process.	**10 Hours**

MODULE - III

Optimization in Design - Introduction, Siddal's Classification of Design Approaches, Optimization by Differential Calculus, Lagrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method of Optimum Design. **Economic Factor Influencing Design -** Product Value, Design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break – even Analysis, Economic of a New Product Design.	**10 Hours**

MODULE - IV

Human Engineering Considerations In Product Design - Introduction, Human being as Applicator of Forces, Anthropometry; Man as occupant of Space, The Design of Controls, of controls, the Design of Displays, Man/Machine Information Exchange. **Value Engineering and Product Design -** Introduction, Historical Perspective, What is Value?	**12 Hours**

Nature and Measurement of Value, Normal Degree of Value, Importance of Value, The Value analysis Job Plan, Creativity, Steps to Problems-solving and Value Analysis, Value Analysis Test, Value Engineering Idea Generation Check-list Cost Reduction through value engineering case study on Tap Switch Control Assembly, Material and Process Selection in Value Engineering Modern Approaches to Product Design: Concurrent Design and Quality Function Deployment (QFD).	

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
O1	Understand Asimow's model to design products, optimizing phases, production-consumption cycle, and incorporating allowances, process capability, and tolerance effectively.	CL3
CO2	Utilize product strategies, design practices, material properties, and production processes to create functional, aesthetically pleasing, and efficient products.	CL3
CO3	Identify optimization techniques and economic analysis to enhance product design, ensuring safety, reliability, competitiveness, and manufacturing efficiency.	CL3
CO4	Integrate human engineering, value engineering, and modern design approaches to create user-centric, cost-effective, and high-quality product designs.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programe Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2						2				2	2	3	2
CO2	3	2						2				2	2	3	2
CO3	3	2						2				2	2	3	2
CO4	3	2						2				2	2	3	2

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Engineering Mechanics – A Textbook of Applied Mechanics," by S. Ramamrutham, Dhanpath Rai PublishingCompany Ltd.
2. "Engineering Mechanics: Statics," by Andrew Pytel and Jaan Kiusalaas.
3. "Vector Mechanics for Engineers: Statics" by Ferdinand P. Beer, E. Russell Johnston Jr., and David Mazurek.

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)(if any):

1. https://www.coursera.org/learn/engineering-mechanics-statics
2. https://www.youtube.com/playlist?list=PLwdnzlV3ogoV7wYUV1S1FnfjCX0L8DAJX

INTRODUCTION TO HYDRAULICS AND PNEUMATICS

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	BME704Q4	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40L	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Basic knowledge about hydraulic and pneumatic systems

COURSE OBJECTIVES:

- Understand the basic hydraulic and pneumatic system and their techniques.
- To understand the concept and operation principle of automation systems and their controls.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporate for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- Case Studies

COURSE CONTENTS

MODULE - I

Introduction to hydraulic systems: Pascal's law, source of hydraulic power, pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance. **Hydraulic actuators and motors**: Linear hydraulic actuators (cylinders), mechanics of hydraulic cylinder loading, rotary hydraulic actuators, gear motors, vane motors and piston motors. **Control components in hydraulic systems:** Directional control valves, symbolic representation, constructional features, pressure control valves - direct and pilot operated types, flow control valves. **Maintenance of hydraulic systems:** Hydraulic oils, desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers.	**10 Hours**

MODULE - II

Introduction to Pneumatic systems: Choice of working medium, characteristics of compressed air, preparation of compressed air: filters, regulators, lubricators. **Pneumatic actuators:** Linear actuators (cylinders) and their types, conventional type of cylinder working, end cushioning, seals, rod less cylinders and their types, rotary actuators and their types, air motors. **Control components in pneumatic systems**: Directional Control valves, design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.	**10 Hours**

MODULE - III

Hydraulic Circuit Design: Control of single and double acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors. **Pneumatic Circuit Design:** Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and exhaust air throttling, Use of Logic gates - OR and AND gates in pneumatic applications, Automatic reciprocation of pneumatic cylinders.	**10 Hours**

MODULE - IV

Multi-cylinder Applications: Coordinated and sequential motion control, Motion and control diagrams, Multicylinder circuit design methods- Classic method, Signal elimination methods- idler roller & cascading method, principle & application examples (up to two cylinders). **Electro-Pneumatic control:** Electrical control devices- push button switch, limit switch, pressure switch, relays, solenoid operated DCVs, electropneumatic control circuitry for single and double acting cylinder applications.	**10 Hours**

COURSE OUTCOMES

Upon completion of this course, the students will be able to:		
CO No.	**Course Outcome Description**	**Bloom's Taxonomy Level**
CO1	Apply the principles of hydraulic systems and components to analyze and troubleshoot basic fluid power circuits used in industrial applications.	CL3

CO2	Apply the working principles of pneumatic actuators and control components to develop basic pneumatic circuits for industrial applications.	CL3
CO3	Analyze hydraulic and pneumatic circuits to determine the functional behavior of actuators, control strategies, and sequence operations in fluid power systems.	CL4
CO4	Evaluate multi-cylinder and electro-pneumatic circuits to determine control sequences and select appropriate components for industrial automation applications.	CL4

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		2			2				2		3	
CO2	3	3	2		2			2				2		3	
CO3	3	3	2		2			2				2		3	
CO4	3	3	2		2			2				2		3	

3: Substantial (High) | **2: Moderate (Medium)** | **1: Poor (Low)**

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT DETAILS

Continuous Internal Assessment (CIA) (50%)				Semester End Exam (SEE) (50%)
Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
I	II	III		
Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
40%	30%	30%	100%	100%
MI			MI	MI
MII	MII		MII	MII
	MIII	MIII	MIII	MIII
		MIV	MIV	MIV

ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	05
2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10

10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

Note: The assignments mentioned above may be provided appropriately to the students belonging to different bands

SEE QUESTION PAPER PATTERN:

- The question paper will have two parts, A and B.
- The Question 1 in Part A is mandatory and can have any number of sub questions each of 1-3 marks totalling to 20 covering all the four modules.
- In Part B, Question 2 and 3 will be compulsory from first and second module.
- The Question No. 4 and 5 will be set from Module 3 and Question No. 6 or 7 from Module 4, with choice in respective modules.
- The students have to answer 4 full questions in Part B, wherein, there is no choice in Modules 1 and 2, however, will have choice in Modules 3 and 4.

REFERENCE BOOKS:

1. "Fluid Power with applications", Anthony Esposito, 7th Edition, Pearson India Education, New Delhi, 2013.
2. "Hydraulics and Pneumatics", Andrew Parr, 9th Edition, Jaico Publishing house, 2005.
3. "Oil Hydraulic Systems", S.R. Majumdar, 1st Edition, Tata McGraw Hill, 2002.
4. "Pneumatic Systems", S.R. Majumdar, 1st Edition, Tata McGraw Hill, 2002.
5. "Hydraulics and Pneumatics", Jagadeesha T, I.K. International Publishing House Pvt. Limited, 2015.

REFERENCE WEB LINKS AND VIDEO LECTURES:

1. https://archive.nptel.ac.in/courses/112/106/112106300/
2. https://archive.nptel.ac.in/courses/112/105/112105047/

Computer Integrated Manufacturing Lab

(Effective from the Academic Year 2022 - 2023)

SEMESTER - VII

Course Code	**BME705L**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of Machining processes and Industrial automation concepts

COURSE OBJECTIVES:

- To introduce various coordinate systems and programming formats used in CNC turning and milling.
- To enable students to interpret and apply G-codes and M-codes for part programming in turning and milling operations.
- To train students in writing CNC programs with and without canned cycles for basic and intermediate level components.
- To develop hands-on skills in cutting path generation and toolpath simulation using CAD/CAM software like SolidWorks.

TEACHING - LEARNING STRATEGY:

Following are some sample strategies that can be incorporated for the Course Delivery

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Demonstration
- Expert Talk/Webinar/Seminar
- Hands on Training on CNC Programming

PRE-REQUISITE EXPERIMENTS

Exp. No.	Description
1	Calculations of Machining parameters for Turning, Facing, Thread cutting, Grooving.
2	Understanding various forces involved in the machining process using a merchant circle diagram.

LIST OF EXPERIMENTS

Exp. No.	Description
1	Determination of various coordinate systems used in CNC Programming.
2	Understand and learning the various Codes used in CNC Turning and CNC Milling
3	Simple CNC programming for Turning and Facing using without standard cycle.
4	Simple CNC programming for Turning and facing using with standard cycle.
5	CNC program for Step turning with and without using Standard cycle
6	CNC program for Step turning with and without using Standard cycle (Canned Cycle)
7	CNC program for End milling/Slot milling without using sub program
8	CNC program for End milling/Slot milling with using sub program
9	CNC program for Drilling milling without using sub program
10	CNC program for Drilling milling with using sub program
11	Cutting path generation for various complex and intricate machining process using Solid Works
12	Cutting path generation for various complex and intricate machining process using Solid Works

COURSE OUTCOMES

Upon completion of this course, the students will be able to:

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify and apply appropriate coordinate systems and codes used in CNC part programming for turning and milling operations.	CL3
CO2	Develop CNC part programs with and without canned cycles for turning, facing, step turning, and slot milling.	CL3
CO3	Implement sub-programming techniques in CNC drilling and milling to improve machining efficiency.	CL3
CO4	Generate cutting tool paths for intricate machining operations using SolidWorks CAM and simulate the machining process.	CL3

CO-PO-PSO MAPPING

CO No.	Programme Outcomes (PO)												Programme Specific Outcome (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1	1	3	1			2	1		1	2	2	
CO2	2	2	1	1	3	1			2	1		1	2	2	
CO3	2	2	1	1	3	1			2	1		1	2	2	
CO4	2	2	1	1	3	1			2	1		1	2	2	
CO5	2	2	1	1	3	1			2	1		1	2	2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

Assessment will be both CIA and SEE. Students learning will be assessed using Direct and Indirect methods:

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Laboratory Work (A)	50 %	25
	Laboratory Test (B)	30 %	15
	Open Ended Experiments /Mini Projects (C)	20 %	10
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).
Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).
Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).
- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

The Sum of marks obtained across (A) and (B) will be the Final CIA marks.

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by

considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)

- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.
- In all the cases, the assessments will be done based on the criteria designed by the Course Coordinator.

SEE QUESTION PAPER PATTERN:

- All laboratory experiments should be included for practical examination, from which students are allowed to pick one experiment from the lot.
- SEE shall be conducted for 100 Marks and the marks will be scaled down to 50.
- General Marks Distribution: Procedure + Conduction + Viva = 20% + 50% + 30%.
- Change of experiment is allowed only once and 20% of the marks allotted to the Procedure will be made ZERO (if a question carries two experiments, both should be changed). The evaluation will be done for 80% of the total maximum marks.

REFERENCE BOOKS:

1. Principles of CAD/CAM by P N Rao
2. Automation and production systems by M P Groover

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES):

1. **https://www.digimat.in/nptel/courses/video/112105211/L01.html**