SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

DEPARTMENT OF MECHANICAL ENGINEERING

Program

Robotics & Automation

2024

Scheme & Syllabus

Effective from the Academic Year 2024 - 2025

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. in ROBOTICS & AUTOMATION

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	BRA302G	OBJECT ORIENTED PROGRAMMING USING C++	CSE	CSE	03	00	02	03	03	50	50	100	04
3	IPCC	BRA303G	MATERIAL SCIENCE AND MANUFACTURING	ME	ME	03	00	02	03	03	50	50	100	04
4	PCC	BRA304T	MECHANICS OF MATERIALS	ME	ME	03	00	00	03	03	50	50	100	03
5	PCCL	BRA305L	MACHINE DRAWING AND GD&T	ME	ME	00	00	02	00	03	50	50	100	01
6	ESC/ ETC/PLC	BRA306Wx	ESC / ETC / PLC	ME	ME	03	00	00	03	03	50	50	100	03
7	UHV	BHU307TK	UHV COURSE	ME	ME	01	00	00	00	01	50	50	100	01
8	AEC/SEC	BRA308Ax	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			
BRA306W1	INTRODUCTION TO ROBOTICS	BRA306W3	BASIC COMMUNICATION SYSTEM
BRA306W2	INTRODUCTION TO AUTOMATION	BRA306W4	LINEAR INTEGRATED CIRCUITS

ABILITY ENHANCEMENT COURSE I / SKILL ENHANCEMENT COURSE - I			
BRA308A1	DATA WRANGLING, ANALYSIS AND VISUALIZATION	BRA308A3	SENSORS AND ACTUATORS LAB
BRA308A2	GENERATIVE DESIGN LAB	BRA308A4	SOFT ROBOTICS AND COMPOSITES LAB

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	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/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.

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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	BRA401G	ANALOG AND DIGITAL ELECTRONICS CIRCUITS	ECE	ECE	03	00	02	03	03	50	50	100	04
2	IPCC	BRA402G	INSTRUMENTATION AND CONTROL SYSTEMS	ME	ME	03	00	02	03	03	50	50	100	04
3	PCC	BRA403T	THEORY OF MACHINES	ME	ME	03	00	00	03	03	50	50	100	03
4	PCC	BRA404T	DATA STRUCTURES	CSE	CSE	03	00	00	03	03	50	50	100	03
5	PCCL	BRA405L	ROBOTICS PROGRAMING LABORATORY	ME	ME	00	00	02	00	03	50	50	100	01
6	ESC/ ETC/PLC	BRA406Wx	ESC / ETC / PLC	BSC	BSC	03	00	00	03	03	50	50	100	03
7	UHV	BHU407TK	UNDERSTANDING HARMONY AND ETHICAL CONDUCT	ME	ME	01	00	00	00	01	50	50	100	01
8	AEC	BRA408Ax	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	BRA406W3	SMART MATERIALS
BRA406W2	SENSORS AND ACTUATORS	BRA406W4	UNMANNED AERIAL VEHICLES
ABILITY ENHANCEMENT COURSE IV / SKILL ENHANCEMENT COURSE - II			
BRA408A1	MACHINE LEARNING LAB	BRA408A3	PROGRAMMABLE LOGIC CONTROLLER LAB
BRA408A2	PROTOTYPE FABRICATION LAB	BRA408A4	MACHINING 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	-

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.

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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	BRA501G	HYDRAULIC AND PNEUMATIC SYSTEMS	ME	ME	03	00	02	03	03	50	50	100	04
2	IPCC	BRA502G	ROBOT OPERATING SYSTEM	ME	ME	03	00	02	03	03	50	50	100	04
3	PCC	BRA503T	ROBOT KINEMATICS AND DYNAMICS	ME	ME	03	00	00	03	03	50	50	100	03
4	PCC	BRA504T	DESIGN AND ANALYSIS OF ALGORITHMS	CSE	CSE	03	00	00	03	03	50	50	100	03
5	PCCL	BRA505L	DIGITAL TWIN USING VIRTUAL INSTRUMENTATION LAB	ME	ME	00	00	02	00	03	50	50	100	01
6	PEC	BRA506Ex	PROFESSIONAL ELECTIVE I	ME	ME	03	00	00	03	03	50	50	100	03
7	PROJ	BRA507P	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			
BRA506E1	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	BRA506E3	MODEL-BASED SYSTEMS ENGINEERING
BRA506E2	EMBEDDED SYSTEMS PROGRAMMING	BRA506E4	SOFT ROBOTICS

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.

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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.

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(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	BRA601T	TECHNOLOGY ENTREPRENEURSHIP AND BUSINESS ECONOMICS	ME	ME	03	00	00	03	03	50	50	100	03
2	IPCC	BRA602G	ADVANCED RISC MACHINES	ECE	ECE	03	00	02	03	03	50	50	100	04
3	PCC	BRA603T	ROBOT DESIGN	ME	ME	03	00	00	03	03	50	50	100	03
4	PEC	BRA604Ex	PROFESSIONAL ELECTIVE COURSE II	ME	ME	03	00	00	03	03	50	50	100	03
5	OEC	BRA605Qx	OPEN ELECTIVE COURSE-I	ME	ME	03	00	00	03	03	50	50	100	03
6	PROJ	BRA606P	PROJECT WORK PHASE I	ME	ME	00	00	02	02	03	50	50	100	02
7	PCCL	BRA607L	CNC AND 3D PRINTING LABORATORY	ME	ME	00	00	02	00	03	50	50	100	01
8	AEC	BRA608Ax	ABILITY ENHANCEMENT COURSE V / SKILL ENHANCEMENT COURSE V	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			
BRA604E1	COMPUTER VISION AND DEEP LEARNING	BRA604E3	PRINCIPLES OF INDUSTRY 5.0
BRA604E2	CLOUD AND FOG COMPUTING	BRA604E4	COGNITIVE COMPUTING FOR ROBOTICS AND AUTOMATION
OPEN ELECTIVE COURSE - I			
BRA605Q1	INTRODUCTION TO ROBOTICS	BRA605Q3	INTRODUCTION TO AUTOMATION
BRA605Q2	INTRODUCTION TO CPS	BRA605Q4	INTRODUCTION TO ROBOT OPERATING SYSTEMS
ABILITY ENHANCEMENT COURSE III / SKILL ENHANCEMENT COURSE - III			
BRA608A1	DEEP REINFORCEMENT LEARNING USING PYTHON	BRA608A3	ARM AND EMBEDDED SYSTEMS LAB
BRA608A2	STRUCTURAL SIMULATION LAB	BRA608A4	NONDESTRUCTIVE TESTING LAB

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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.

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(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	BRA701G	INDUSTRIAL INTERNET OF THINGS	ME	ME	03	00	02	03	03	50	50	100	04
2	PCC	BRA702T	INDUSTRIAL AUTOMATION	ME	ME	03	00	00	03	03	50	50	100	03
3	PEC	BRA703Ex	PROFESSIONAL ELECTIVE COURSE	ME	ME	03	00	00	03	03	50	50	100	03
4	OEC	BRA704Qx	OPEN ELECTIVE COURSE	ME	ME	03	00	00	03	03	50	50	100	03
5	PCCL	BRA705L	COMPUTER VISION AND DEEP LEARNING LAB	ME	ME	00	00	02	00	03	50	50	100	01
6	PROJ	BRA706P	PROJECT WORK PHASE II	ME	ME	00	00	02	10	03	50	50	100	06
									TOTAL		**300**	**300**	**600**	**20**

PROFESSIONAL ELECTIVE COURSE

BRA703E1	DEEP REINFORCEMENT LEARNING	BRA703E3	AGENTIC AI
BRA703E2	BIG DATA ANALYTICS	BRA703E4	MEDICAL ROBOTICS

OPEN ELECTIVE COURSE

BRA704Q1	INTRODUCTION TO ROBOT PROGRAMMING	BRA704Q3	INTRODUCTION TO PLC AND SCADA
BRA704Q2	AI APPLICATIONS IN ROBOTICS AND AUTOMATION	BRA704Q4	SOFT ROBOTICS

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.

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B.E. in ROBOTICS & AUTOMATION

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	BRA801Ex	PROFESSIONAL ELECTIVE COURSE- IV (12 WEEKS NPTEL) *	NPTEL		00	00	00	06	AS PER GUIDELINES OF NPTEL				03
2	OEC	BRA802Qx	OPEN ELECTIVE COURSE- III (12 WEEKS NPTEL) *	NPTEL		00	00	00	06	AS PER GUIDELINES OF NPTEL				03
3	INT	BRA803I	INTERNSHIP (14-20 WEEKS) RESEARCH INTERNSHIP/ INDUSTRY INTERNSHIP/ RURAL INTERNSHIP	ME	ME	00	00	00	18	03	50	50	100	09
4	SEM	BRA804S	RESEARCH ORIENTED TECHNICAL SEMINAR	ME	ME	00	00	00	03	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.

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LINEAR ALGEBRA AND NUMERICAL TECHNIQUES
(Effective from the Academic Year 2024-2025)

III SEMESTER

Course Code	**BMA301TR**	**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.
- Understand the Basic Concept of Linear Transformation.

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
- MOOC/NPTEL Courses

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 and Fourier transforms: **Fourier series**: Periodic functions, Dirichlet's condition. Fourier series of periodic functions and an arbitrary period. Half-range Fourier series. Practical harmonic analysis and applications. **Fourier transforms:** infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms—application of the Fourier transforms.	**12 Hours**

MODULE - IV

Z-Transforms and Vector Spaces:	**12 Hours**

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. **Vector Spaces:** Vector spaces and Null subspaces, Review of Rank and Row reduced form, Independence, Basis and dimension, Rank-Nullity Theorem, Linear Transformations. Symmetric Matrices: inner products, inner product spaces, length orthogonality, orthogonal sets, orthogonal projections, the Gram-Schmidt orthogonalization procedure, and least square problems.	

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. Apply infinite and inverse Fourier transforms, including sine and cosine transforms, to solve practical problems.	CL3
CO4	Apply z-transform techniques to analyze and solve difference equations and apply inner product concepts, orthogonality, the Gram-Schmidt process, and solve least squares problems.	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			
CO2	3	3	1		3	1					1			
CO3	3	2	1		2	2								
CO4	3	3	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 totalling 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, 43rd Ed., 2015.
2. David C lay, "Linear Algebra and its Application "Cambridge university Press 3rd Edition 2017B.S. C Ray Wylie, Louis C Barrett: "Advanced Engineering Mathematics", 6th Edition,
3. B.V Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill,
4. Bernard Kolman and David R. Hill, "Introductory Linear Algebra with Applications", Pearson Education (Asia) Pte. Ltd, 7th edition, 2003.
5. Gilbert Strang, "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia, 2003

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

1. https://kahedu.edu.in/naac/C-3/Additional%20documents/E-content/58.pdf
2. VTU e-Shikshana Program.
3. https://www.youtube.com/watch?v=LJ-LoJhbBA4
4. https://onlinecourses.swayam2.ac.in/cec23_ma05/preview

OBJECT ORIENTED PROGRAMMING WITH C++

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BRA302G**	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: Overview of C++, Sample C++ program, Different data types,operators, expressions, and statements, arrays and strings, pointers & user defined types , Function Components, argument passing, inline functions, function overloading, recursive functions, Classes & Objects – I: Class Specification, Class Objects, Scope resolution operator, Access members, Defining member functions, Data hiding, Constructors, Destructors, Parameterized constructors, Static data members, Functions.	**10 Hours**
MODULE - II	
Classes & Objects –II: Friend functions, Passing objects as arguments, Returning objects, Arrays of objects, Dynamic objects, Pointers to objects, Copy constructors, Generic functions and classes, Applications Operator overloading using friend functions such as +, - , pre-increment, post-increment, [ ] etc., overloading <>	**10 Hours**
MODULE - III	
Inheritance – I: Base Class, Inheritance and protected members, Protected base class inheritance, Inheriting multiple base classes, Inheritance – II: Constructors, Destructors and Inheritance, Passing parameters to base class constructors, Granting access, Virtual base classes Virtual functions, Polymorphism: Virtual function, Calling a Virtual function through a base class reference, Virtual attribute is inherited, Virtual functions are hierarchical, Pure virtual functions, Abstract classes, Using virtual functions, Early and late binding	**10 Hours**
MODULE - IV	
I/O System Basics, File I/0: C++ stream classes, Formatted I/O, I/O manipulators, fstream and the File classes, File operations. Exception Handling, STL: Exception handling fundamentals, Exception handling options STL: An overview, containers, vectors, lists, maps	**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 OOPs Concept, C++ language features, various Datatypes and Operators	CL2
CO2	Understand the concepts of Classes &Objects, friend function , constructors & destructors in program design.	CL4
CO3	Demonstrate various forms of inheritance, base class constructors, operator overloading, runtime polymorphism and Generic Programming.	CL4
CO4	Demonstrate various Stream classes, I/O operations and exception handling.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Write a C++ program to sort the elements in ascending and descending order	CO1	CL2
2.	Write a C++ program to find the sum of all the natural numbers from 1 to n	CO1	CL2
3.	Write a C++ program to swap 2 values by writing a function that uses call by reference technique	CO1	CL2
4.	Implement a C++ Program to demonstrate the concepts of Class, Object and Constructors by creating a class that holds the basic information of students belonging to an Engineering College	CO2	CL3
5.	Develop a C++ Program to simulate a calculator that performs basic arithmetic operations on integer and floating-point numbers using the concepts of function overloading.	CO2	CL3
6.	Write a base class Shape with a function area() using C++. Create two classes Circle and Rectangle that calculate and return their area. Write a program to show the area of a circle and a rectangle.	CO3	CL3
7.	Write a C++ program that includes a base class Animal with a virtual function sound(). Derive two classes Dog and Cat from Animal. Show concepts of overriding.	CO3	CL3
8.	Write a c++ program to demonstrate concepts of exception handling	CO4	CL3
9.	Write a c++ program to demonstrate file I/O operations	CO4	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	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	30 %	15

	(CIE)		
	Activity Based Assessment (As suggested by the BoS)	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.

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. Deitel's "C++ How to Program", Deitel & Deitel, 2007.
2. Robert Lafore, "Object-Oriented Programming in C++", Sams, 2007.
3. Bjarne Stroustrup, "The C++ Programming Language: Special Edition", AddisonWesley,2000.
4. E.Balaguruswamy, "Object Oriented Programming with C++, " TMH, 6th Edition, 2013.
5. Bhushan Trivedi, "Programming with ANSI C++", Oxford Press, 2nd Edition, 2019.

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

1. Basics of C++ - https://www.youtube.com/watch?v=BClS40yzssA
2. Functions of C++ - https://www.youtube.com/watch?v=p8ehAjZWjPw

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

Course Code	**BRA303G**	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 commonly used in engineering applications.**
- **Explore the mechanical properties of metals and their alloys, polymers, ceramics and composites**
- **Understand various manufacturing process, their classification and applications**
- **Gain exposure in the field of welding and advanced manufacturing process**

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: Stress strain diagrams showing ductile and brittle behavior of materials, Mechanical properties in plastic range.	**10 Hours**

MODULE - II

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 **Ceramics:** Structure type sand properties and applications of ceramics. Mechanical/ Electrical behaviour and processing of Ceramics. **Plastics:** Various types of polymers/plastics and their applications. Mechanical behaviour and processing of plastics, Failure of plastics.	**10 Hours**

MODULE - III

Introduction to Manufacturing Process: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Casting: Introduction to Casting process & steps involved. Study of important moulding process: Green sand, core sand, dry sand, sweep mould, CO2 mould, shell mould, investment mould, plaster mould, cement bonded mould. Various components produced by casting process, Advantages & Limitations	**10 Hours**

MODULE - IV

Non-traditional Machining Processes: Need for non-traditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining.	**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	Gain knowledge composites, their processing methods, advantages, challenges and applications and understand the knowledge of the mechanical behavior of ceramics and polymers.	CL2
CO3	Gain knowledge of the casting and welding process, their advantages, applications and limitations	CL4
CO4	Classify the various nontraditional machining process principle, application, advantages and limitation and further to gain working principles of various nontraditional machining process	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.	Preparation of sand mould using hand cut molds	3	CL4
6.	Fabrication of Fibre reinforced composites using land lay-up methods (Demonstration)	3	CL4
		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:

V.Raghavan, Materials Science and Engineering, , PHI, 2002
Donald R. Askland and Pradeep.P. Phule, The Science and Engineering of Materials, Cengage Learning, 4lh Ed., 2003. Production Technology, HMT, Tata McGraw Hill, 2001.
Manufacturing Science, Amitabh Ghosh and Mallik, Affiliated East West Press, 2003
Foundations of Material Science and Engineering by Smith,Mcgrawhill, 4th edition 2009
Material science and Engineering Introduction by William D Callister, Wiley, 2006
Manufacturing Technology, SeropekalpakjainSteuen.R.Sechmid, Pearson Education Asia, 5th Edition 2006. 21 4. New York 2001
Plastics Engineering- RJ Crawford, 3rd Edition, Butterworth Heinemann 1998

REFERENCE WEB LINKS AND VIDEO LECTURES (E - RESOURCES)

https://www.youtube.com/watch?v=tTnXn498F90&list=PLWv6RLxuaVQwMg6kFEoeeMEGT WNnr7Jmr
https://www.youtube.com/watch?v=VrlCH1FZSJM&list=PLWv6RLxuaVQwMg6kFEoeeMEG TWNnr7Jmr&index=2

MECHANICS OF MATERIALS

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BRA304T**	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.

COURSE 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	**10 Hours**

uniformly distributed constant / varying loads. **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

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

Course Code	**BRA305L**	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

INTRODUCTION TO ROBOTICS
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BRA306W1**	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, four 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 robots.	**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	
Robots 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

INTRODUCTION TO AUTOMATION

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BRA306W2**	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 Electrical and Electronics Engineering
- Fundamentals of Mechanical Systems
- Basic Programming Concepts (optional but beneficial)

COURSE OBJECTIVES:

- To familiarize students with the fundamental concepts, types, and levels of automation used in industrial and manufacturing environments.
- To introduce key hardware components such as sensors, actuators, and industrial communication protocols applied in automation systems.
- To develop foundational skills in PLC hardware configuration and ladder logic programming using basic control instructions like timers and counters.
- To enable students to understand and explain industrial control architectures such as SCADA, DCS, and HMI, and their roles in process automation.

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	
Fundamentals of Automation: Introduction to Automation: Definition, history, scope, and relevance in manufacturing and service industries, Types of Automation: Fixed, programmable, and flexible automation, Automation Hierarchy: Device level, cell level, system level, and enterprise level. Basic Elements of Automation: Sensors, actuators, controllers, Benefits and Limitations of Automation, Introduction to Industrial Control Systems: PLC, SCADA, and DCS overview, Overview of Robotics in Automation.	**10 Hours**
MODULE - II	
Sensors and Actuators in Automation: Role of Sensors and Actuators in Automation, Types of Sensors: Proximity, photoelectric, ultrasonic, vision sensors, Types of Actuators: Pneumatic, hydraulic, electric actuators, solenoids, stepper and servo motors, Basic Signal Conditioning and Data Acquisition Concepts, Introduction to Industrial Communication Protocols: 4-20 mA, Fieldbus, Modbus basics.	**10 Hours**
MODULE - III	
Introduction to Programmable Logic Controllers: Basics of PLC: Architecture and working principles, PLC Programming Fundamentals: Ladder Logic, Functional Block Diagrams. Introduction to Programming Instructions: Timers, Counters, Latches, Basic Arithmetic, Simple Applications of PLC: Start/Stop processes, motor control, Interfacing Sensors and Actuators with PLC	**10 Hours**
MODULE - IV	
Automation Systems and Applications: Industrial Automation Systems: Overview of SCADA and DCS in industrial setups. Basic Introduction to Human Machine Interface (HMI), Overview of Industry 4.0 and Smart Manufacturing, Automated Material Handling Systems, Case Studies: Automated assembly lines, packaging systems, robotic arms in production, Trends in Industrial Automation: IIoT, Digital Twin (conceptual).	**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 automation concepts and distinguish between different levels and types of automation used in industrial environments.	CL2
CO2	Select and integrate appropriate sensors, actuators, and basic industrial communication protocols for automation applications.	CL2
CO3	Develop and simulate PLC ladder logic programs using basic instructions like timers, counters, and interlocks for simple control processes.	CL2
CO4	Explain the architecture and functions of SCADA, HMI, and distributed control systems within modern industrial automation setups.	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:

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson Education, 2016.
2. Frank Lamb, Industrial Automation: Hands On, McGraw Hill Education, 2013.
3. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Learning Pvt. Ltd., 2013.
4. Frank D. Petruzella, Programmable Logic Controllers, 4th Edition, McGraw Hill Education, 2016.
5. Hugh Jack, Automating Manufacturing Systems with PLCs, Creative Commons, freely available online at www.engineeringbookspdf.com or www.michigantech.edu.

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

1. NPTEL Video Lectures on Industrial Automation and Control - https://nptel.ac.in/courses/108105062
2. Free PLC Training: Learn PLC Programming online - https://www.plcacademy.com/
3. Automation and Control Concepts - MIT OpenCourseWare Lecture Notes - https://ocw.mit.edu/courses/mechanical-engineering/2-14-analysis-and-design-of-feedback-control-systems-spring-2014/
4. SCADA Training - https://www.youtube.com/playlist?list=PLDJvwEGpPRLbx8VssK0YgQ1wv1_XBb_v3

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BASIC COMMUNICATION SYSTEM

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	BRA306W3	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 Digital Circuits

COURSE OBJECTIVES:

- Classify essential elements of electronic communications.
- Model Amplitude, Frequency & Phase modulations, and Amplitude demodulation.
- Employ the basics of sampling and quantization in a communication system.
- Make use of the various digital modulation schemes in communication blocks.
- Demonstrate concepts of wireless communication.

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 Electronic Communications: Historical perspective, Electromagnetic frequency spectrum, signal and its representation, Elements of electronic communications system, primary communication resources, signal transmission concepts, Analog and digital transmission, Modulation, Concept of frequency translation, Signal radiation and propagation. **Noise:** Classification and source of noise**.**	**10 Hours**

MODULE - II

Amplitude Modulation Techniques: Types of analog modulation, Principle of amplitude modulation, AM power distribution, Limitations of AM. **Angle Modulation Techniques:** Principles of Angle modulation, Theory of FM-basic Concepts, Theory of phase modulation**.** **Analog Transmission and Reception:** AM Radio transmitters, AM Radio Receivers**.**	**10 Hours**

MODULE - III

Sampling Theorem and pulse Modulation Techniques: Digital Versus analog Transmissions, Sampling Theorem, Classification of pulse modulation techniques, PAM, PWM, PPM, PCM, Quantization of signal.	**10 Hours**

MODULE - IV

Digital Modulation Techniques: Types of digital Modulation, ASK, FSK, PSK, QPSK (No Derivations) **Evolution of wireless communication systems:** Brief History of wireless communications, Advantages of wireless communication, disadvantages of wireless communications, wireless network generations, Comparison of wireless systems, Evolution of next-generation networks, Applications of wireless communication.	**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 operation of communication systems.	CL3
CO2	Classify the techniques of Amplitude and Angle modulation.	CL3
CO3	Apply the concept of sampling and quantization in communication systems.	CL3
CO4	Identify the concepts of different digital modulation techniques, frequency reuse and its principles in wireless communications 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			2			
CO2	3	3	1					1	1			2			
CO3	3	3	1					1	1			2			
CO4	3	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
	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. Analog and Digital Communications by T L Singal, McGraw Hill Education (India) Private Limited.
2. Wireless Communications by T L Singal, McGraw Hill Education (India) Private Limited.
3. Modern Digital and Analog Communication Systems B. P. Lathi, Oxford University Press., 4th ed, 2010,
4. Communication Systems: Analog and Digital, R.P. Singh and S.Sapre: TMH 2nd edition, 2007.
5. Introduction to Wireless Telecommunications systems and Networks by Gray J Mullett, Cengage learning.

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

1. https://nptel.ac.in/courses/117102059
2. https://nptel.ac.in/courses/106106097

LINEAR INTEGRATED CIRCUITS

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BRA306W4**	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 in circuit analysis and in phasor algebra

COURSE OBJECTIVES:

- To understand the fundamentals, characteristics, and internal architecture of operational amplifiers.
- To develop the ability to design and analyze linear and non-linear applications using op-amps.
- To gain knowledge of special purpose ICs such as voltage regulators, oscillators, timers, and PLLs.
- To apply linear integrated circuits in solving real-time engineering and practical electronic problems.

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

Operational Amplifier Characteristics — **10 Hours**

Op-amp symbol, terminals, packages and specifications - Block diagram Representation of op-amp-Ideal op-amp & practical op-amp - Open loop & closed loop configurations – DC & AC performance characteristics of op-amp – Frequency compensation - Noise – Differential amplifiers – General Description, Manufacturer's Specification, Electrical Characteristics and internal schematic of 741 op-amps.

MODULE - II

Op–Amp Applications — **10 Hours**

Basic op-amp circuits: Inverting & Non-inverting voltage amplifiers - Voltage follower - Summing, scaling & averaging amplifiers - AC amplifiers. Linear Applications: Instrumentation Amplifiers-V-to-I & I-to-V converters-Differentiators & Integrators. Non-linear Applications: Precision Rectifiers – Wave Shaping Circuits (Clipper and Clampers) – Log and Antilog Amplifiers – Analog voltage multiplier circuit and its applications – Operational Trans-Conductance Amplifier (OTA) - Comparators and its applications – Sample and Hold circuit.

MODULE - III

Waveform Generators and PLL — **10 Hours**

Waveform Generators: Sine-wave Generators – Square / Triangle / Saw-tooth Wave generators. IC 555 Timer: Monostable operation and its applications – Astable operation and its applications. PLL: Operation of basic PLL-Closed loop analysis of PLL-Voltage Controlled Oscillator-PLL applications. Active Filters & Voltage Regulator (9 hours) Filters: Comparison between Passive and Active Networks-Active Network Design – Filter Approximations-Design of LPF, HPF, BPF and Band Reject Filters – State Variable Filters – All Pass Filters – Switched Capacitor Filters.

MODULE - IV

Data Conversion Devices Digital- to-Analog Conversion: DAC Specifications – DAC circuits – Weighted Resistor DAC-R-2R Ladder DAC-Inverted R-2R Ladder DAC-Monolithic DAC Analog-to-Digital conversion: ADC specifications-ADC circuits-Ramp Type ADC-Successive Approximation ADC-Dual Slope ADC-Flash Type ADC- Monolithic ADC.	**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	Students will be able to explain the symbol, terminals, packages, specifications, and basic characteristics of operational amplifiers, including ideal and practical behavior.	CL3
CO2	Design and analyze linear and non-linear op-amp applications for signal processing.	CL3
CO3	Analyze and design waveform generators, timer circuits, PLL-based systems, active filters, and voltage regulators.	CL3
CO4	Understand the concepts DAC and ADC architectures, specifications, and their applications in data conversion.	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			
CO2	3	3	2					2				2			
CO3	3	3	3					2				2			
CO4	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	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. Robert F. Coughlin, Frederick F. Driscoll, “Operational-Amplifiers and Linear Integrated Circuits”, 6th Edition, Prentice Hall, 2001.
2. Sergio Franco, “Design with operational amplifier and analog integrated circuits”, McGraw Hill, 1997

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

1. https://nptel.ac.in/courses/117102059
2. https://nptel.ac.in/courses/106106097

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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/

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

Course Code	**BRA308A1**	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 with 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	2		2					2		2		3	
CO2	3	2	2		2					2		2		3	
CO3	3	2	2		2					2		2		3	
CO4	3	2	2		2					2		2		3	
CO5	3	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**
	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

GENERATIVE DESIGN LAB

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BRA308A2**	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

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

SENSORS AND ACTUATORS LAB
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BRA308A3**	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 Electrical and Electronic Concepts

COURSE OBJECTIVES:

- To understand the operating principles of different types of sensors and actuators.

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	Study & Calibration of measuring temperature using different Sensors & study the characteristics of Thermocouple, RTD, and Thermistor.
2	Study & Calibration of LVDT for displacement measurement.
3	Study of vibration measurement instrument
4	Water level controller using Ultrasonic sensor and Relay module
5	Measurement of level in a tank using a capacitance-type level probe
6	Study of strain gauge sensor
7	Study of load cell sensor
8	Study of pressure sensor
9	DC motor control using Arduino
10	Steeper motor controlled with potentiometer

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 calibration techniques to temperature sensors	CL 3
CO2	Implement displacement and vibration measurement systems using sensors	CL 3
CO3	Construct basic sensor-actuator control circuits involving relay modules and feedback mechanisms for applications like water level control and process automation.	CL 3
CO4	Demonstrate the ability to measure physical parameters such as level, pressure, and force using capacitive probes, ultrasonic sensors, and load cells.	CL 3

CO5	Use microcontrollers (Arduino) to interface and control actuators, including DC motors and stepper motors	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. Patranabis.D, Sensors and Transducers, Wheeler publisher, 1994.
2. Thomas. G. Bekwith and Lewis Buck.N, “Mechanical Measurements”, Oxford and IBH publishing Co. Pvt. Ltd.,

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

1. https://sl-coep.vlabs.ac.in/
2. https://archive.nptel.ac.in/courses/108/108/108108147/

Soft Robotics and Composites Lab

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BRA308A4**	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: Engineering Physics

COURSE OBJECTIVES:

- To introduce students to the basic principles and applications of soft robotics and composite materials.
- To provide hands-on experience with the fabrication and testing of soft robotic systems and composite structures.
- To encourage innovation through problem-solving and design-based experiments.
- To enable students to analyze material behavior and system response using simple modeling and simulation tools.

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	Fabrication of a Pneumatic Soft Actuator: Create a bending soft actuator using silicone rubber and test its actuation with pneumatic input.
2	Characterization of Hyperelastic Materials: Perform tensile tests on silicone elastomers and plot stress-strain behavior.
3	Design and Build a Soft Gripper: Fabricate and test a simple soft robotic gripper for handling delicate objects
4	Electroactive Polymer Demonstration: Investigate actuation in dielectric elastomers under applied voltage.
5	Basic Composite Laminate Fabrication: Create a fiber-reinforced polymer laminate using hand layup method and test for flexural strength.
6	Vibration Damping in Composite Panels: Measure and compare damping properties of composite vs metallic panels.
7	3D Printing of Soft Structures: Use flexible filaments to print soft robotic parts and evaluate performance.
8	Finite Element Simulation of a Soft Beam: Simulate deformation of a soft material beam under load.
9	Smart Material Demonstration: Shape Memory Alloy Wire: Fabricate a simple actuator using SMA wire and test actuation temperature and force.
10	Bioinspired Locomotion Mechanism: Design and demonstrate a simple crawling or inching soft robot inspired by biological systems.

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 working principles of pneumatic soft actuators and describe the stress-strain behavior of hyperelastic materials based on tensile test results	CL 2
CO2	Describe the working principles of soft robotic grippers and explain the actuation behavior of electroactive polymers under applied voltage	CL 2
CO3	Explain the fabrication process of fiber-reinforced polymer laminates and describe the differences in vibration damping characteristics between composite and metallic panels	CL 2
CO4	Explain the principles of 3D printing soft structures using flexible filaments and describe the basic concepts of finite element simulation for deformation analysis of soft material beams	CL 2
CO5	Explain the actuation behavior of shape memory alloy wires and describe the principles behind bioinspired soft robotic locomotion mechanisms	CL 2

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		3	
CO2	3	2	3		2					2		2		3	
CO3	3	2	3		2					2		2		3	
CO4	3	2	3		2					2		2		3	
CO5	3	2	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**
	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:

- Soft Robotics: Trends, Applications and Challenges" by Cecilia Laschi and Barbara Mazzolai
- "Introduction to Composite Materials Design" by Ever J. Barbero
- "Soft Robotics: Materials, Design, and Applications" by Mohammad D. Matarić
- "Mechanics of Composite Materials" by Robert M. Jones

ANALOG AND DIGITAL ELECTRONICS CIRCUITS

(Effective from the Academic Year 2025 - 2026)

IV SEMESTER

Course Code	**BRA401G**	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:

- Fundamental knowledge of Embedded systems and basic concepts of ARM architecture and programming.

COURSE OBJECTIVES:

This course will enable students to learn:

- Characteristics of JFETs and MOSFETs
- The demonstration and analyze Operational Amplifier circuits and their applications.
- Combinational Logic circuits, Simplification of Algebraic Equations using Karnaugh Maps and Quine McClusky Techniques.
- Decoders, Encoders, Digital multiplexers, Adders and Subtractors, Binary comparators, Latches, and Master Slave Flip-Flops.
- Synchronous and Asynchronous Sequential circuit design and analysis.
- Registers and Counters, A/D and D/A converters.

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

Field Effect Transistors: Junction Field Effect Transistors, MOSFETs, Differences between JFETs and MOSFETs, Biasing MOSFETs, FET Applications, CMOS Devices. Introduction to Operational Amplifier: Ideal v/s Practical Op Amp, Performance Parameters, Operational Amplifier Application Circuits: Peak Detector Circuit, Comparator, Active Filters.	**10 Hours**

MODULE - II

The Basic Gates: Review of Basic Logic Gates, Positive and Negative Logic, Introduction to HDL. Combinational logic circuits. **Logic Circuits:** Sum-of-Products Method, Truth Table to Karnaugh Map, Pairs Quads, and Octets, Karnaugh Simplifications, Don't-care Conditions, Product-of-sums Method, Product-of- sums simplifications, Simplification by Quine-McClusky Method, HDL Implementation Models. **Data-Processing Circuits:** Multiplexers, Demultiplexers, 1-of-16 Decoder, BCD to Decimal Decoders, Seven Segment Decoders, Encoders.	**10 Hours**

MODULE - III

Data-Processing Circuits: Parity Generators and Checkers, Magnitude Comparator, Programmable Array Logic, Programmable Logic Arrays, HDL Implementation of Data Processing Circuits.	**10 Hours**

Flip-Flops: FLIP-FLOP Timing, JK Master-slave FLIP-FLOP, Switch Contact Bounce Circuits, Various Representation of FLIP-FLOPs, HDL Implementation of FLIP FLOP.	

MODULE - IV

Registers: Types of Registers, Serial In - Serial Out, Serial In – Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Applications of Shift Registers. **Counters:** Decade Counters, Presettable Counters, Counter Design as a Synthesis problem, A Digital Clock, and Counter Design using HDL. **D/A Conversion and A/D Conversion:** Binary Ladders, D/A Converters, D/A Accuracy and Resolution, A/D Converter-Simultaneous Conversion, A/D Converter-Counter Method, Continuous A/D Conversion.	**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 operational concepts of JFETs, MOSFETs, and Operational Amplifier Circuits in the construction of different electronic circuits.	CL3
CO2	Solve the SOP and POS expressions and simplify the Boolean functions using K-map and Quine - McCluskey minimization Technique in complex digital circuits.	CL3
CO3	Construct combinational logic circuits like Multiplexers, Demultiplexers, Encoders, decoders, PLAs, and PALs in digital circuits.	CL3
CO4	Develop sequential logic circuits like flip-flops and registers and counters in digital circuits, Operate a variety of ADCs, DACs in real time application.	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Carry out the experiment on i. Transfer and drain characteristics of a JFET ii.Transfer and drain characteristics of a MOSFET	CO1	CL3
2.	Operate the JFET/MOSFET as a switch and visualize by using the bulb.	CO1	CL3
3.	Carry out the experiment on i. Demorgan's Theorem for 2 variables. ii.3-variable function by using basic gates and simplify using K-Map reduction method and implement the reduced function using basic gates.	CO2	CL3
4.	Solve the Sum of Product (SOP) and Product of Sum (POS) expressions using universal gates.	CO2	CL3
5.	Demonstrate the adder and subtractor circuit using logic gates using Verilog.	CO2	CL3
6.	Demonstrate the i. Code conversion circuits using Verilog. ii.Magnitude comparator circuit using Verilog.	CO3	CL3
7.	Develop JK Master slave flip flop using only NAND gates	CO3	CL3
8.	Construct 2 bit magnitude comparator circuit and implement with HDL.	CO4	CL3
9.	Develop Mod-5 Counter using JK Flip flop.	CO4	CL3
10.	Operate Mod N Synchronous Up Counter and Down Counter using JK Flip- flop.	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	3	3	2		3			2	2	2		2			
CO2	3	2	2		3			2	2	2		2			
CO3	3	2	2	1	3			2	2	2		2			

CO4	3	2	2	1	3			2	2	2		2			
CO5	3	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
	Practical Session (Laboratory Component)	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%)			**Practical Sessions (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:

- 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:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Anil K Maini, Varsha Agarwal, Electronic Devices and Circuits, Wiley, 2012.
2. Donald P Leach, Albert Paul Malvino & Goutam Saha, Digital Principles and Applications, 8th Edition, Tata McGraw Hill, 2015.
3. M. Morris Mani, Digital Design, 4th Edition, Pearson Prentice Hall, 2008.
4. David A. Bell, Electronic Devices and Circuits, 5th Edition, Oxford University Press, 2008

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

1. https://www.youtube.com/watch?v=HicZcgdGxZY&list=PLwjK_iyK4LLCnW-df-_53d-6yYrGb9zZc
2. https://www.youtube.com/watch?v=Pc1aFloxSMw&list=PLwjK_iyK4LLCnW-df-_53d-6yYrGb9zZc&index=3
3. https://www.youtube.com/watch?v=PoOm_G4s1dE&list=PLwjK_iyK4LLCnW-df-_53d-6yYrGb9zZc&index=2

INSTRUMENTATION AND CONTROL SYSTEMS
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BRA402G**	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, Physics and Programming Concepts

COURSE OBJECTIVES:

- To understand and have hands-on knowledge of measurement systems and methods with emphasis on different Transducers, intermediate modifying and terminating devices.
- To understand the working principles and hands-on applications of Data Acquisition Systems
- To apply the concepts of virtual instrumentation and implement the same in measurement of different physical parameters.
- To understand and apply the hands-on knowledge of control systems & building control system models.
- To understand time domain response and frequency of control systems using block diagrams and other graphical techniques.

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

Measurement system and basic concepts of measurement methods: Definition, Significance of measurement, Generalized measurement system, Static characteristics, System response, Time delay. Errors in measurement, Classification of errors. **Transducers:** Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical, Electronic transducers, Relative comparison of each type of transducers; Intermediate Modifying and Terminating Devices: Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Terminating devices, Cathode ray oscilloscope, Oscillographs.	**10 Hours**

MODULE - II

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	**10 Hours**

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.	

MODULE - III

Introduction to Control 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. **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.	**10 Hours**

MODULE - IV

Visualizing control systems Block diagram algebra, Reduction of block diagram, Signal flow graphs, gain formula for signal flow graphs. Introduction to frequency response diagrams (Root Locus, Bode plot)	**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 measurement systems and transducers to identify appropriate devices and classify measurement errors in practical applications.	CL3
CO2	Organize the DAQ systems and analyze the virtual instrumentation using VI software.	CL3
CO3	Apply control system principles to model physical systems and evaluate their time-domain performance using standard test signals	CL3
CO4	Analyze the control systems with the aid of block diagram reduction, signal flow graphs, and frequency response plots such as Root Locus and Bode diagrams.	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Demonstration of the measurement system using Micrometer and Vernier caliper	CO1	CL3
2.	Demonstrate to classify different types of errors in measurements through experimental data.	CO1	CL3
3.	Demonstration of the measurement system using Transducers.	CO1	CL3
4.	Demonstration on DAQ hardware system	CO2	CL3
5.	Demonstration and a mini training on a VI Software with assessment and assignment on a construction of a simple lab view model.	CO2	CL3
6.	Demonstration of the dynamic behaviour of the mechanical system	CO3	CL3
7.	Demonstration and hand-on exercise on time domain specification using Scilab/Python	CO3	CL3
8.	Case study of PID Controller.	CO3	CL2
9.	Demonstration of constructing of Routh's array using Scilab-Xcos/OpenModelica/other system modelling software	CO4	CL3
10.	Demonstration of Graphical modelling of root locus using Scilab-Xcos/OpenModelica/other system modelling 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	3	3	2		2			1	1			1	3		
CO2	2	2	1		2			1	1			1	3		
CO3	3	2	2		2			1	1			1	3		
CO4	3	3	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)	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 Metrology, R.K.Jain, Khanna Publishers, 2009
2. Control Engineering, U.A. Bakshi & V.U. Bakshi, Technical Publications, 2021
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
6. Engineering Metrology and Measurements, N.V. Raghavendra, L.Krishnamurthy, Oxford Higher Education, 2013
7. Modern Control Engineering, K. Ogata, Pearson Education India, 2015

REFERENCE WEB LINKS 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

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

Course Code	**BRA403T**	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 machines, machine elements such as gears and gear drives etc.

COURSE OBJECTIVES:

- To discuss the basic terminologies of kinematics, mechanisms and machines, working of the mechanisms, inversions of the mechanisms, lower pair mechanisms.
- To analyse the velocity and acceleration of the different planar mechanisms analytically.
- To analyse and design the different types of belt drives, chain drives and brakes.
- To discuss the terminologies of spur gears and gear trains and to determine gear parameters such as length of path and arc of contact, contact ratio
- To discuss the various types of cams and to create cam profiles according to the requirements using displacement diagrams.

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	
Mechanisms and Machines: Types of Motion, Links, Kinematic Pair, Types of Joints, Degrees of Freedom, Classification of Kinematic Pairs, Kinematic Chain, Linkage, Mechanism and Structure, Inversions of Four-bar and Slider Crank Mechanism, Mobility of Mechanisms, Grubbler's criterion, Grasshof's criteria. **Mechanisms with Lower Pair:** Straight Line Motion Mechanisms, Intermittent Motion Mechanism, Toggle Mechanism, Pantograph, Steering Gear Mechanisms.	**10 Hours**
MODULE - II	
Velocity and Acceleration Analysis of Mechanisms: Absolute and Relative Motion, Velocity and Acceleration Diagrams for Four-bar Mechanisms and Slider Crank Mechanism. **Velocity by Instantaneous Centre Method:** Arnold-Kennedy Theorem, Klein Construction.	**10 Hours**
MODULE - III	
Friction and Friction Drives: Types of friction, Laws of Friction, Coefficient of Friction, Rolling Friction, Flat Belt, V Belt, Velocity Ratio in Belt Drives, Law of Belting, Ratio of Friction Tensions in Belts, Power Transmitted by Belts, Chain drives, Types of Brakes, Block and Shoe Brake, Band Brake, Internal Expanding Shoe Brake, Numerical in Belts Drives only. **Cams:** Types of Cams and Followers, Cam Terminology, Cam Profile Layout with Knife-edge, Roller follower including SHM and UARM.	**10 Hours**
MODULE - IV	
Gears and Gear Trains: Classification of Gears, Gear Terminology, Law of Gearing, Velocity of sliding, Gear Teeth Profile, Path of Contact, Arc of Contact. Types of Gear Trains, Analysis of Speed of an Epicyclic Gear Train (tabular method). **Balancing of Rotating Masses:** Concepts and Types of Balancing, Effects of Unbalanced Masses, Balancing of Revolving Masses in the Same Plane and in Different Planes, Balancing of Reciprocating Masses, Numerical on Balancing of Revolving Masses only.	**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 kinematic principles to examine the configuration and motion behavior of common planar mechanisms.	CL3
CO2	Analyze the velocity and acceleration of planar mechanisms using velocity diagrams, instantaneous center method, and Klein's construction.	CL4
CO3	Examine the operation of friction drives and cam mechanisms to assess their effectiveness in transmitting power and motion.	CL4
CO4	Investigate gear trains and balancing techniques to determine their impact on mechanical system dynamics and performance.	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	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. "Theory of Machines", Rattan S.S., McGraw Hill Education India Private Limited, 4th Edition, 2014.
2. "Theory of Machines", R.S. Khurmi, S Chand, 14th edition, 2020.
3. "Theory of Machine and Mechanisms" Si Edition, John J. Uicker, Gordon R. Pennock& Joseph E. Shigley, Oxford University Press, 4th Edition, 2014.
4. "Theory of Machines: Kinematics and Dynamics", Sadhu Singh, Pearson Education India, 3rd edition, 2011.

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

1. https://nptel.ac.in/courses/112104121
2. https://nptel.ac.in/courses/112105268

DATA STRUCTURES

(Effective from the Academic Year 2024 - 2025)

IV SEMESTER

Course Code	**BRA404T**	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 C programming basics.

COURSE OBJECTIVES:

- To introduce fundamental data structures and their classifications, and to familiarize students with basic memory operations and data manipulation techniques.
- To develop an understanding of linear and nonlinear data structures such as stacks, queues, and linked lists, and apply them to solve computational problems.
- To enable students to implement and apply tree and graph data structures in various real-life and computational applications.
- To familiarize students with basic searching, sorting, and hashing techniques and their applications in organizing and accessing data efficiently.

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/Laboratory Based Learning
- Case Studies
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Introduction to Data Structures Introduction: Data Structures, Classifications (Primitive & Non-Primitive), Data structure Operations, Review of Arrays, Structures. Pointers and Dynamic Memory Allocation Functions. Array Operations: Traversing, inserting, deleting, searching, and sorting. Sparse Matrices with arrays. Strings: Basic Terminology, String Operations and Knuth Morris Pattern Matching algorithms.	**10 Hours**

MODULE - II

Stacks and Queues **Stacks:** Definition, Stack Operations, Arrays Representation of Stacks, Stacks using Dynamic Array's, Stack Applications: Polish notation, Infix to postfix conversion, evaluation of postfix expression. **Queues:** Definition, Arrays Representation, Queue Operations, Circular Queues, Circular queues using Dynamic array's, Dequeues, Priority Queues. Programming Examples.	**10 Hours**

MODULE - III	
Linked Lists: Definition, Representation of linked lists in Memory. Linked list operations: Traversing, Searching, Insertion, and Deletion. Doubly Linked lists, Circular linked lists, and header linked lists. Applications of Linked lists – Polynomials addition, Sparse matrix representation.	**10 Hours**

MODULE - IV	
Trees: Introduction, Binary Trees array and linked representation, traversal, Additional Binary Tree Operations', Threaded Binary Trees, Binary Search Trees - Definition, Insertion, Deletion, Traversal, Searching. Application of Trees-Evaluation of Expression, Programming Examples. **Graphs**: Definitions, Terminologies, Matrix and Adjacency List Representation of Graphs, Elementary Graph operations, Traversal methods: Breadth First Search and Depth First Search. **Sorting and Searching**: Radix sort, Address Calculation Sort.	**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 appropriate data structures such as arrays, strings, and sparse matrices to solve computational problems using suitable operations and algorithms.	CL3
CO2	Apply stack and queue data structures to develop solutions for expression evaluation, conversion techniques, and real-world programming applications.	CL3
CO3	Apply linked list concepts to implement dynamic memory-based data storage, including insertion, deletion, and traversal operations for problem solving.	CL3
CO4	Apply tree, graph, sorting, and searching techniques to design efficient solutions for data organization, traversal, and retrieval problems.	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		3								3	2	
CO2	3	2	2		3								3	2	
CO3	3	2	2		3								3	2	
CO4	3	3	3	2	3							2	3	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%
M I (Full)			M I	MI
M II (50%)	M II (50%)		M II	MII
	M III (60%)	M III (40%)	M III	MIII
		M IV (Full)	M IV	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
11	NPTEL Certification	75 %	15

SEE QUESTION PAPER PATTERN:

- The question paper will have **TWO** parts viz. **Part A (20 Marks)** and **Part B (80 marks)**
- In Part A, the Question 1 shall be mandatory and can have any number of sub-questions each of 01-03 marks totaling to 20 covering all four modules
- In Part B, a student has to answer 4 FULL questions where,
  a. Question no. 2 shall be set from Module I for a maximum of 20 marks and will be mandatory. The question may contain a maximum of three sub questions
  b. Question no. 3 shall be set from Module II for a maximum of 20 marks and will be mandatory. The question may contain a maximum of three sub questions
  c. Question no. 4 shall be set from Module III for a maximum of 20 marks and shall contain choice i.e. 4A or 4B. Each question may contain a maximum of three sub questions (i.e. 4Ai, 4Aii, 4Aiii (OR) 4Bi, 4Bii, 4Biii)
  d. Question no. 5 shall be set from Module IV for a maximum of 20 marks and shall contain choice i.e. 5A or 5B. Each question may contain a maximum of three sub questions (i.e. 5Ai, 5Aii, 5Aiii (OR) 5Bi, 5Bii, 5Biii).

Reference Books:

1. Fundamentals of Data Structures in C, Ellis Horowitz and Sartaj Sahni, Universities Press, 2nd Ed, 2014.
2. Data Structures Schaum's Outlines, Seymour Lipschutz, McGraw Hill, Revised 1st Ed, 2014
3. Data Structures: A Pseudo-code approach with C, Gilberg & Forouzan, Cengage Learning, 2nd Ed, 2014
4. Data Structures using C, Reema Thareja, Oxford press, 3rd Ed, 2012

5. An Introduction to Data Structures with Applications, Jean-Paul Tremblay & Paul G. Sorenson, McGraw Hill, 2nd Ed, 2013
6. Data Structures using C, A M Tenenbaum, PHI, 1989

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

1. https://www.youtube.com/watch?v=3Xo6P_V-qns&t=201s
2. https://ds2-iiith.vlabs.ac.in/exp/selection-sort/index.html
3. https://nptel.ac.in/courses/106/102/106102064
4. https://ds1-iiith.vlabs.ac.in/exp/stacks-queues/index.html
5. https://ds1-iiith.vlabs.ac.in/exp/linked-list/basics/overview.html
6. https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html
7. https://ds1-iiith.vlabs.ac.in/exp/tree-traversal/index.html

ROBOTICS PROGRAMMING LABORATORY
IV SEMESTER

Course Code	**BRA405L**	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**,** Python

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

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

ENGINEERING STATISTICS & PROBABILITY
(Effective from the Academic Year 2024-2025)

SEMESTER - IV

Course Code	**BRA406W1**	**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, Basics of Statistics and Complex Numbers

COURSE OBJECTIVES:

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

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
- MOOC/NPTEL Courses

COURSE CONTENTS

MODULE - I

Probability Distribution Functions: — **8 Hours**

Discrete and Continuous Random variables, Probability mass function, Probability density functions, Binomial, Poisson distributions-problems. Exponential and Normal distributions-problems. Stochastic Process, Markov Chains.

MODULE - II

Curve Fitting and Statistical Methods: — **8 Hours**

Curve Fitting : Curve fitting by the method of least squares- fitting the curves of the form $y = ax + b$, $y = a^x b$, $y = ae^{bx}$ and $y = ax^2 + bx + c$.

Correlation: Karl Pearson's coefficient of correlation, regression analysis-lines of regression, Rank Correlation. rank correlation.

MODULE - III

Calculus of Complex functions & Construction of Analytic functions: — **12 Hours**

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, Application of analytic functions

MODULE - IV

Sampling Theory and Symmetric Matrices: **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. **Symmetric matrices and quadratic forms**: Diagonalization of symmetric matrices, Quadratic forms, constraint optimization, singular value decomposition, Application to image processing statistics.	**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	Utilize Discrete and Continuous random variables and Probability distribution functions to use for the probability models in engineering field	CL3
CO2	Apply curve fitting, statistical correlation methods, regression analysis, and optimization techniques to solve mathematical and real-world problems.	CL3
CO3	Apply calculus principles to construct complex functions, fostering problem-solving skills for mechanical engineering.	CL3
CO4	Validate hypothesis testing and apply diagonalization, quadratic forms, SVD, and LU decomposition to solve system of simultaneous linear equations.	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			
CO2	3	3	1		3	1					1			
CO3	3	2	1		3	2								
CO4	3	3	1		3	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 totalling 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.
2. S.C Gupta and V.K.Kapoor: Fundamentals of Mathematical Statistics" by, 12th Edition,Sultan Chand & Sons Publications 2012
3. David C lay, " Linear Algebra and its Application, " Cambridge University Press 3rd Edition 2017
4. C Ray Wylie, Louis C Barrett: "Advanced Engineering Mathematics", 6th Edition,
5. B.V Ramana: "Higher Engineering Mathematics", 11th Edition, Tata McGraw-Hill,
6. Bernard Kolman and David R. Hill, "Introductory Linear Algebra with Applications", Pearson Education (Asia) Pte. Ltd, 7th edition, 2003.
7. Gilbert Strang, "Linear Algebra and its Applications", 3rd edition, Thomson Learning Asia, 2003.

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

1. https://www.youtube.com/watch?v=8Kg21jBCm-k
2. https://www.youtube.com/watch?v=Wa6kaCwyYRk
3. https://onlinecourses.nptel.ac.in/noc21_ma74/preview
4. http://www.class-central.com/subject/math(MOOCs)
5. http://academicearth.org/
6. http://www.bookstreet.in.
7. VTU e-Shikshana Program.

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SENSORS AND ACTUATORS
(Effective from the Academic Year 2024 - 2025)
III SEMESTER

Course Code	**BRA406W2**	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 electronics, Measurements and Instruments

COURSE OBJECTIVES:

- Understanding basic laws and phenomena on which operation of sensors and actuators-transformation of energy is based,

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	
SENSORS: Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal.	**10 Hours**
MODULE - II	
INDUCTIVE & CAPACITIVE TRANSDUCER: Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn. Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications:- capacitor microphone, capacitive pressure sensor, proximity sensor.	**10 Hours**
MODULE - III	
ACTUATORS: Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator.	**10 Hours**
MODULE - IV	
SENSOR MATERIALS AND PROCESSING TECHNIQUES: Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA 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	Apply the principles of sensor, sensor selection and signal transmission.	CL3

CO2	Utilize the working principles and characteristics of inductive and capacitive transducers.	CL3
CO3	Demonstrate the selection and implementation of appropriate actuators.	CL3
CO4	Illustrate the selection of suitable sensor materials and fabrication techniques.	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	3	3						2				3	3	1	
CO2	3	3						2				3	3	1	
CO3	3	3						2				3	3	1	
CO4	3	3						2				3	3	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

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. Patranabis.D, “Sensors and Transducers”, Wheeler publisher, 1994.
2. Sergej Fatikow and Ulrich Rembold, “Microsystem Technology and Microbotics”, First edition, Springer –Verlag NEwyork, Inc, 1997.
3. Jacob Fraden, “Hand Book of Modern Sensors: Physics, Designs and Application” Fourth edition, Springer, 2010.
4. Robert H Bishop, “The Mechatronics Hand Book”, CRC Press, 2002.
5. Thomas. G. Bekwith and Lewis Buck.N, Mechanical Measurements, Oxford and IBH publishing Co. Pvt. Ltd.,

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

SMART MATERIALS

(Effective from the Academic Year 2024 - 2025)

V SEMESTER

Course Code	**BRA406W3**	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 Manufacturing

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)												Program meSpecific 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):

UNMANNED AERIAL VEHICLES
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	BRA406W4	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 physics
- Mechanics and fluid dynamics
- Engineering mathematics (such as differential equations and vectors)

COURSE OBJECTIVES:

- Comprehend the basic aviation history and UAV systems.
- Acquire the knowledge of basic aerodynamics, performance, stability and control.
- Understand the propulsion, loads and structures.

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 UAV Systems: Aviation history and evolution of UAVs, overview of UAV systems and subsystems, UAV classifications based on size and mission, very small UAVs, small UAVs, medium UAVs, large UAVs, UAV roles in military, civil, and commercial sectors, key definitions and terminology, basic UAV architecture and functional components.	**10 Hours**

MODULE - II

Aerodynamics and Performance of UAVs: Fundamental aerodynamic equations, aircraft polar and wing characteristics, induced drag and boundary layer, total air-vehicle drag, flapping wing concepts, climbing flight, range and endurance calculations for propeller-driven aircraft, range calculations for jet-driven aircraft, flight guidance and trajectory planning.	**10 Hours**

MODULE - III

Stability, Control, and Autopilot Systems: Overview of flight stability, longitudinal stability, lateral stability, dynamic stability, aerodynamic control surfaces, pitch control, lateral control, inner and outer control loops, classification of flight control systems, sensors, controllers, actuators, airframe-control interaction, modes of operation in autopilot, sensor types supporting autopilot.	**10 Hours**

MODULE - IV

Propulsion, Structure, and Mission Control: Thrust generation and powered lift, two-cycle engine, rotary engine, gas turbine, electric motors, electrical power sources for UAVs, types of loads and dynamic loading, skin, core, and reinforcement materials, resin materials, sandwich construction and fabrication techniques, air vehicle and payload control, surveillance and reconnaissance payloads, weapon payloads, communication and other payloads, data-link functions and parameters, launch and recovery systems, trade-offs in launch and recovery methods.	**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 evolution, classification, architecture, and roles of UAV systems across various applications.	CL2
CO2	Apply basic aerodynamic principles to evaluate UAV performance parameters such as lift, drag, range, and endurance.	CL3
CO3	Analyze UAV stability and control systems including autopilot components and control loop structures.	CL4
CO4	Evaluate propulsion systems, structural design techniques, and mission planning strategies including payload integration and launch/recovery trade-offs.	CL5

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			
CO2	3	2										2			
CO3	3	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. Unmanned Aerial Vehicles: DOD's Acquisition Efforts, Publisher: Alpha Editions, ISBN13:9781297017544.
2. Valavanis, Kimon P., Unmanned Aerial Vehicles, Springer, 2011.
3. Valavanis, K., Vachtsevanos, George J., Handbook of Unmanned Aerial Vehicles, Springer, 2015.
4. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
5. Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN13: 9789385505034.

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

1. NPTEL Video on Design of Fixed Wing Unmanned Aerial Vehicles - https://youtube.com/playlist?list=PLFW6lRTa1g83B1HdU2mece6QLeBrtspL7&si=lQU1RzRlrixlOEb0
2. NPTEL Video on Drone Systems and Control Intro - https://youtu.be/LePUzKzl9c0?si=R6XGdAC6ogkqaszh
3. NPTEL Video on Classifications of UAVs/Drones - https://youtu.be/sWjpuXluEmY?si=n2vpIK7et26JPISU

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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

DEEP REINFORCEMENT LEARNING USING PYTHON
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BRA408A1**	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 Python programming
- Linear Algebra and Probability
- Fundamentals of Machine Learning
- Basic concepts in Neural Networks and Deep Learning

COURSE OBJECTIVES:

- To understand the foundational concepts of reinforcement learning (RL) and Markov Decision Processes.
- To explore model-free and model-based reinforcement learning algorithms.
- To implement and experiment with deep reinforcement learning algorithms using Python and libraries such as TensorFlow or PyTorch.
- To develop practical problem-solving skills by applying RL to real-world and simulated environments.

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 OpenAI Gym and Python Setup for RL
2	Implementation of Multi-Armed Bandit Problem
3	Solving GridWorld using Dynamic Programming (Policy Iteration/Value Iteration)
4	Monte Carlo Methods for Blackjack Environment
5	Temporal Difference Learning: TD(0) and SARSA on Cliff Walking
6	Q-learning on FrozenLake Environment
7	Deep Q-Network (DQN) with Experience Replay
8	Policy Gradient Method using REINFORCE Algorithm
9	Actor-Critic Methods with Advantage Estimation
10	Application Project: Solving a Custom Environment (e.g., CartPole, MountainCar, FlappyBird)

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 theoretical foundations of reinforcement learning, including policies, value functions, and Bellman equations.	CL 2
CO2	Analyze and compare model-free and model-based learning algorithms.	CL 4
CO3	Analyze and implement deep reinforcement learning models using Python.	CL 4
CO4	Apply reinforcement learning algorithms to environments using OpenAI Gym or similar platforms.	CL 3
CO5	Evaluate the performance of reinforcement learning agents and fine-tune models using hyperparameter optimization techniques.	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			
CO2	3	3			1							2			
CO3	3	2	3	2	3				2	1	2	2			
CO4	2	2	3	2	3				2	1		2			
CO5	2	3	2	3	3				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. Sutton, R. S., & Barto, A. G. (1998). Reinforcement learning: An introduction (Vol. 1, No. 1, pp. 9-11). Cambridge: MIT press.
2. Lapan, M. (2018). Deep Reinforcement Learning Hands-On: Apply modern RL methods, with deep Q-networks, value iteration, policy gradients, TRPO, AlphaGo Zero and more. Packt Publishing Ltd.
3. Saito, S., Wenzhuo, Y., & Shanmugamani, R. (2018). Python Reinforcement Learning Projects: Eight hands-on projects exploring reinforcement learning algorithms using TensorFlow. Packt Publishing Ltd.
4. Graesser, L., & Keng, W. L. (2019). Foundations of deep reinforcement learning: theory and practice in Python. Addison-Wesley Professional.
5. Morales, M. (2020). Grokking deep reinforcement learning. Manning.

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

1. Reinforcement Learning Specialization (Coursera – University of Alberta)
   https://www.coursera.org/specializations/reinforcement-learning
2. RL with Python and PyTorch – PyTorch Tutorials
   https://pytorch.org/tutorials/intermediate/reinforcement_q_learning.html
3. Deep Reinforcement Learning (YouTube – MIT 6.S091 by Lex Fridman)
   https://www.youtube.com/playlist?list=PLrAXtmErZgOdEF4uf1g6r1cuF6z3xHFXd
4. CS285: Deep Reinforcement Learning (UC Berkeley – Prof. Sergey Levine)
   https://rail.eecs.berkeley.edu/deeprlcourse/
5. Practical Deep Reinforcement Learning with PyTorch (YouTube – Aladdin Persson)
   https://www.youtube.com/playlist?list=PLhhyoLH6IjfxeoooqP9rhU3HJIAVAJ3Vz
6. Intro to Reinforcement Learning (YouTube – David Silver, DeepMind)
   https://www.youtube.com/playlist?list=PLqYmG7hTraZBiG_XpjnPrSNw-1XQaM_gB

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PROTOTYPE FABRICATION LAB

(Effective from the Academic Year 2024 - 2025)

IV SEMESTER

Course Code	**BRA408A2**	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

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PROGRAMMABLE LOGIC CONTROLLER LAB
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code	**BRA408A3**	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 Electrical and Electronic Concepts

COURSE OBJECTIVES:

- To understand the operating principles of different types of sensors and actuators.

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	Design and test the various logic gates
2	Operation of motor with OFF Delay Timer
3	Operation of motor with ON Delay Timer
4	Automate washing machine operations
5	Automate timed motor operation
6	Latching and Unlatching of Motor
7	Sequential motor starting with interlock
8	Control of star delta DOL starter
9	Traffic light control
10	Automatic Indication of Water Tank Level

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply PLC ladder logic to design and test basic logic gates and develop control circuits for motor operation	CL 3
CO2	Apply PLC programming to automate household appliances such as a washing machine, and to develop timed motor operations	CL 3
CO3	Apply PLC-based latching and unlatching circuits, and develop sequential motor starting with interlock	CL 3

CO4	Apply PLC logic to implement star-delta and DOL starter strategies for safe starting and protection of induction motors.	CL 3
CO5	Apply PLC programming to develop and test traffic light control sequencing and automatic water tank level indication systems.	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 Programmable Logic Controllers, Gary Dunning, CENGAGE Learning, 3rd Ed., 2006.
2. Programmable Logic Controllers, John R. Hackworth, Frederick D. Hackworth Jr., Pearson, 2004.

3. Programmable Logic Controllers, W.Bolton, Elsevier, 4th Ed., 2006.

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

1. https://plc-coep.vlabs.ac.in/

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

Course Code	**BRA408A4**	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 Machining science and manufacturing.

COURSE OBJECTIVES:

- To provide an insight to different machine tools, accessories and attachments
- To train students into machining operations to enrich their practical skills
- To inculcate team qualities and expose students to shop floor activities
- To educate students about ethical, environmental and safety 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	Introduction to Machining operations & tools (Lathe machine and Shaper machine)
2	Machining of facing, plain turning, taper turning & step turning.
3	Machining of knurling operation, drilling operation and boring operation.
4	Machining of external thread cutting (Metric & British)
5	Machining of internal thread cutting
6	Machining of eccentric turning.
7	Machining of hexagon in shaping machine
8	Machining of square in shaping machine
9	Cutting of gear teeth using milling machine (Spur Gear)
10	Grinding operations using Surface grinding machine.

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 lathe and shaping machine operations.	CL3
CO2	Perform turning , facing , knurling , thread cutting, tapering, eccentric, turning and allied operations	CL3
CO3	Perform hexagon, square, keyways / slots and grooves etc using shaper	CL3

CO4	Perform gear tooth cutting using milling machine	CL3
CO5	Demonstrate precautions and safety norms followed in Machine Shop	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		1	2			2		2	1
CO2	3	2			3	2		1	2			2		2	1
CO3	3	2			3	2		1	2			2		2	1
CO4	3	2			3	2		1	2			2		2	1
CO5	3	2			3	2		1	2			2		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**
	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. Manufacturing Technology, Serope Kalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006
2. Production Technology, R K Jain Khanna Publications, 2003

3. Production Technology, HMT, Tata Mc Graw Hill, 2001
4. Fundaments in Metal Machining and Machine Tools, G Boothroyed, Mc Graw Hill, 2001
5. Manufacturing Science, Amitabha Ghosh and Mallik, affiliated East West Press, 2003.

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

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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

HYDRAULIC AND PNEUMATIC SYSTEMS
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	BRA501G	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:

- Fundamental knowledge and basic concepts of hydraulic and pneumatic systems

COURSE OBJECTIVES:

- Understand the basic hydraulic and pneumatic systems 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
- 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 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, 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

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Study of construction and operation of hydraulic systems.	1	CL3
2.	Study of construction and operation of pneumatic systems.	2	CL3
3.	Study of ISO/GIS Fluid Power Symbols.	1, 2	CL3
4.	Study of regenerative circuits used in hydraulic systems.	3	CL4
5.	Study of speed control circuits used in pneumatic systems.	3	CL4
6.	Study of circuits used for indirect control of pneumatic actuators.	3	CL4
7.	Study of circuits used for two-way control of pneumatic actuators.	3	CL4
8.	Study of circuit used for synchronizing operation of pneumatic actuators.	4	CL4
9.	Study of circuits used for sequencing operation of pneumatic actuators.	4	CL4
10.	Study of circuits used for the electro pneumatic control of actuators.	4	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)	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. "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 (E - RESOURCES) (If Any):

1. https://archive.nptel.ac.in/courses/112/106/112106300/
2. https://archive.nptel.ac.in/courses/112/105/112105047/

ROBOT OPERATING SYSTEM

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code		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:

- ROS Installed Ubuntu System
- Basic knowledge of Linux command line tools
- Basic programming in Python
- Robotics Basics.

COURSE OBJECTIVES:

- Understand and discuss the fundamental elementary concepts of ROS
- Provide insight into different types of file system
- Understand and discuss the fundamental nodes 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

COURSE CONTENTS

MODULE - I

Introduction –The ROS Equation - History - distributions -difference from other meta-operating systems– services - ROS framework – operating system – releases.	**8 Hours**

MODULE - II

UNIX commands - file system – redirection of input and output - File system security - Changing access rights – process commands – compiling, building and running commands – handling variables	**8 Hours**

MODULE - III

File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands	**8 Hours**

MODULE - IV

Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server. Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo – Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS	**8 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 applications of ROS in real world complex scenarios	CL3
CO2	Work with turtlesim, Gazebo, MoveIt and Rviz	CL3
CO3	Familiarise about the concepts behind navigation	CL3
CO4	Interface with hardware and analyse the issues in hardware interfacing and Program a Robot using ROS and its tool boxes	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Writing a Simple Publisher and Subscriber, Simple Service and Client,Recording and playing back data, Reading messages from a bag file(Python/C++)	CO3	CL3
2.	Getting Started with Turtlesim	CO3	CL3
3.	Familiarisation with Rviz -- Markers: Sending Basic Shapes -- use visualization_msgs/Marker messages to send basic shapes, to send points and lines (C++), Interactive Markers: Writing a Simple Interactive Marker Server, Basic Controls	CO3	CL3
4.	Introduction to tf -- broadcast the state of a robot to tf, get access to frame transformations, Adding a frame, waitForTransform function, Setting up your robot using tf, publish the state of your robot to tf, using the robot state publisher.	CO3	CL3
5.	Building a Visual Robot Model with URDF from Scratch, Building a Movable Robot Model with URDF, Adding Physical and Collision Properties to a URDF Model.	CO3	CL3
6.	Familiarisation with Gazebo--How to get Gazebo up and running,Creating and Spawning Custom URDF Objects in Simulation, Gazebo ROS API for C-Turtle, Simulate a Spinning Top, Gazebo Plugin - how to create a gazebo plugin, Create a Gazebo Plugin that Talks to ROS	CO4	CL3
7.	Create a Gazebo Custom World (Building Editor, Gazebo 3D Models), Add Sensor plugins like Laser, Kinect, etc. to URDF of mobile robot	CO4	CL3
8.	Create a 3DOF robotic arm from scratch	CO4	CL3
9.	Familiarisation with MoveIt through its RViz plugin, Motion Planning with the Panda or other robot models.	CO4	CL3
10.	Create Moveit package for robotic arm simulation and add controllers,Plan a path for a 3DOF Robotic Arm and execute the same, Move the 3DOF arm to a desired goal point	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	3	2	2		3				2	2		3		3	
CO2	3	2	2		3				2	2		3		3	
CO3	3	2	2		3				2	2		3		3	
CO4	3	2	2		3				2	2		3		3	
CO5	3	2	2		3				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
	Practical Session (Laboratory Component)	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%)			**Practical Sessions (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:

- 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:

1. The question paper will have **TEN** full questions from **FIVE** Modules
2. There will be 2 full questions from each module. Every question will carry a maximum of 20 marks.
3. Each full question may have a maximum of four sub-questions covering all the topics under a module.
4. The students will have to answer FIVE full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018 ROBOTICS & AUTOMATION
2. Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013
3. Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2013.
4. AnisKoubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
5. Kumar Bipin, "Robot Operating System Cookbook", Packt Publishing, 2018.
6. Wyatt Newman, "A Systematic Approach to learning Robot Programming with ROS", CRC Press, 2017.
7. Patrick Gabriel, "ROS by Example: A do it yourself guide to Robot Operating System", Lulu, 2012

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

1. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=17&lesson=18
2. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=26&lesson=27
3. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=43&lesson=44
4. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=52&lesson=53
5. https://onlinecourses.nptel.ac.in/noc22_cs93/unit?unit=75&lesson=76

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

ROBOT KINEMATICS AND DYNAMICS
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	BRA503T	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 mathematics and Theory of Machines.

COURSE OBJECTIVES:

- To understand the concept of robot kinematics and learn to represent the position and orientation of robotic systems using mathematical models.
- To understand the concept of forward kinematics and to develop equations for a given robot manipulator.
- To understand the concept of inverse kinematics and its importance in robot control. Solve inverse kinematics problems to determine the joint variables required to achieve a desired end-effector position and orientation.
- To understand the fundamentals of robot dynamics and the forces and torques involved in robotic motion.
- To learn methods for planning and controlling the trajectory of a robot's end-effector.

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: Euler angles Roll, pitch and yaw angles coordinate Transformations, coordinate frames, Rotations, Homogeneous coordinates. **Direct Kinematics:** Link coordinates D-H Representation, The ARM equation. Direct kinematic analysis for Four axis, SCARA Robot and three, five and six axis Articulated Robots.	**10 Hours**

MODULE - II

Inverse Kinematics: The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis RR, RRR, SCARA ROBOT , three and five axis Articulated robot.	**10 Hours**

MODULE - III

Robot Dynamics: Inertia of a link, Recursive formulation of Dynamics using Newton- Euler equation, equation of 2R and 3R manipulators Using Lagrangian, Newton-Euler Formulations.	**10 Hours**

MODULE - IV

Trajectory Planning: Workspace Analysis, work envelope of a Four axis SCARA robot and five axis articulated robot workspace fixtures, the pick and place operations, Joint space technique - continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning	**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 forward kinematics using D-H parameters to differentiate between various configurations of the robot manipulators.	CL4
CO2	Analyze inverse kinematics problems by evaluating tool configurations and solution properties of robot manipulators.	CL4
CO3	Analyze the dynamic behavior of robotic manipulators using Newton–Euler and Lagrangian formulations to derive equations of motion.	CL4
CO4	Analyze trajectory planning techniques by evaluating joint space and Cartesian space motions of SCARA and articulated robots.	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			1	1	1		2	2		
CO2	3	2	1		1			1	1	1		2	2		
CO3	3	2	1					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. "Industrial Robotics" by Groover M. P, Tata McGraw-Hill, 1st Edition, 2013.
2. "Introduction to Robotic Mechanics and Control" by J. J. Criag, Pearson, 3rd Edition, 2013.
3. "Robotic Engineering" by Richard D. Klafter, Prentice Hall, 1st Edition, 2013.
4. "Robotics" by Fu K S, McGraw-Hill, 1st Edition, 2013.
5. "Fundamentals of Robotics Analysis and Control" by Robert J. Schilling, PHI Learning, 2009.
6. "Introduction to Robotics" by Saha S K,, Tata McGraw Hill Education Pvt. Ltd, 2010.

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

1. Mechanism and Robot Kinematics https://onlinecourses.nptel.ac.in/noc23_me118/course

DESIGN AND ANALYSIS OF ALGORITHMS
(Effective from the Academic Year 2024-2025)
IV SEMESTER

Course Code	**BRA504T**	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 Programming Constructs (loops, functions, recursion) – ideally in C/C++.
- Data Structures – including arrays, stacks, queues, linked lists, trees, and graphs.
- Discrete Mathematics – understanding of logic, sets, relations, functions, and proof techniques.

COURSE OBJECTIVES:

- Introduce the fundamentals of algorithm design and mathematical tools for analyzing time and space complexity.
- Explore classical algorithmic paradigms such as brute force, divide-and-conquer, greedy methods, dynamic programming, and backtracking.
- Apply graph algorithms and optimization techniques to solve real-world computational problems.
- Understand computational complexity theory and classify problems into P, NP, NP-complete, and NP-hard categories.
- Equip students with problem-solving strategies for designing efficient algorithms and critically analyzing their performance.

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

Fundamentals of Algorithmic Problem Solving, Important Problem Types. **Brute Force Approaches:** Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching. Exhaustive Search (Travelling Salesman problem and Knapsack Problem). **Decrease-and-Conquer:** Insertion Sort, Topological Sorting. **Divide and Conquer:** Merge Sort, Quick Sort, Multiplication of Large Integers and Strassen's Matrix Multiplication.	**10 Hours**
MODULE - II	
Transform-And-Conquer: Balanced Search Trees, Heaps and Heapsort. **Space-Time Tradeoffs:** Sorting by Counting: Comparison counting sort, Input Enhancement in String Matching: Horspool's Algorithm. **Graph Algorithms:** Network Flows, Flow Networks, Maximum Flows, Ford-Fulkerson, Edmond-Karp, Push Re-label Algorithm, Application of Max Flow to Maximum Matching Problem.	**10 Hours**
MODULE - III	
Dynamic Programming: Three basic examples, The Knapsack Problem and Memory Functions, Warshall's and Floyd's Algorithms. Travelling Salesperson problem. Multistage Graphs **The Greedy Method:** Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees and Codes.	**10 Hours**
MODULE - IV	
Backtracking: General method, N-Queens problem, Sum of subsets problem, Hamiltonian cycles Problems. **Branch and Bound:** Basic concepts, Assignment Problem, Travelling Sales Person problem, 0/1 Knapsack problem. **Np-Complete and Np-Hard Problems:** Basic concepts, Non- deterministic algorithms, P, NP, NP-Complete, and NP-Hard classes.	**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 brute force, divide-and-conquer, and decrease-and-conquer strategies to solve basic computational problems involving sorting, searching, and classical problems.	CL3
CO2	Implement transform-and-conquer techniques, heaps, and graph flow algorithms to solve real-world optimization and network problems.	CL3
CO3	Apply dynamic programming and greedy methods for optimization problems like knapsack, shortest path, and minimum spanning tree.	CL3
CO4	Illustrate solutions for constraint-based problems using backtracking and branch-and-bound methods, and classify problems based on computational complexity (P, NP, NP-complete, NP-hard).	CL3

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**

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. Introduction to the Design and Analysis of Algorithms, By Anany Levitin, 3rd Edition (Indian),2017, Pearson.
2. Introduction to Algorithms, by Cormen, Leiserson, Rivest, and Stein, MIT Press, 3rd Edition, 2009.
3. Computer Algorithms/C++, Ellis Horowitz, Satraj Sahni and Rajasekaran, 2nd Edition, 2014, Universities Press.
4. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI.
5. Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education)

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

1. Design and Analysis of Algorithms: https://nptel.ac.in/courses/106/101/106101060/

DIGITAL TWIN USING VIRTUAL INSTRUMENTATION LAB
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BRA505L**	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 Instrumentation and Control Systems.

COURSE OBJECTIVES:

- To skill the students in the virtual instrumentation.
- To skill the students to design the application using VI software.
- To enable the students to design the application using control structure in VI.
- To enable the students to design, build, and test virtual instrumentation systems for specific 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	To perform basic arithmetic operations such as addition, subtraction, multiplication, and division using numeric functions.
2	To implement logical operations like AND, OR, NOT, and XOR for decision-making in digital systems.
3	To calculate the sum of 'n' numbers using a FOR loop.
4	To compute the factorial of a given number using a FOR loop.
5	To calculate the sum of the first 'n' natural numbers using a WHILE loop.
6	To find the factorial of a number using a WHILE loop.
7	To extract even numbers from an array and sort them in ascending order using a WHILE loop.
8	To determine the maximum and minimum values present in a numeric array using array functions.
9	To create and manage a cluster data structure using bundle and unbundle operations.
10	To demonstrate the use of flat and stacked sequence structures to control the execution flow of multiple processes.
11	To implement a mathematical expression using a formula node for performing complex calculations.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply programming skills to perform basic arithmetic operations such as addition, subtraction, multiplication, and division.	CL 3
CO2	Implement boolean operations effectively within programming constructs.	CL 3

CO3	Use FOR and WHILE loops to compute the sum of 'n' natural numbers and the factorial of a given number.	CL 3
CO4	Apply array manipulation techniques to determine the maximum and minimum values in a dataset.	CL 3
CO5	Develop programming solutions to solve real-world problems using appropriate logic and constructs.	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. Virtual Instrumentation using LABVIEW, Jovitha Jerome, PHI, 2011

2. Virtual Instrumentation using LABVIEW, Sanjay Gupta, Joseph John, TMH, McGraw Hill, Second Edition, 2011.

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

1. https://archive.nptel.ac.in/courses/108/105/108105064/
2. https://archive.nptel.ac.in courses/108/105/108105153/
3. https://www.youtube.com/watch?v=gJ7FIBwA_5s

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BRA506E1**	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 programming
- Understanding of statistics, linear algebra, Probability and Calculus

COURSE OBJECTIVES:

- To understand the importance, principles, and search methods of AI
- To provide knowledge on predicate logic.
- To introduce machine learning fundamentals
- To study of supervised learning algorithms.
- To study about unsupervised learning algorithms.

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 AI: Intelligent systems, Foundations and Sub areas of AI, Applications, Tic-Tac-Toe Game playing, Currents trend and developments of AI, General problem solving, Characteristics of problem, Constraint satisfaction. **Search Techniques and Game playing:** Exhaustive searches, Heuristic search techniques, AO* Algorithm.	**10 Hours**

MODULE - II

Game playing concepts: Game playing, Bounded look-ahead strategy, Alpha-beta pruning, Two-player perfect information games. **Logic concepts:** Propositional calculus, Propositional logic, Natural deduction system, Axiomatic system, Semantic tableau system in Propositional logic.	**10 Hours**

MODULE - III

Introduction to Machine learning: Machine Learning, Types of Machine Learning, Main challenges of Machine Learning, Testing and Validating, Concept Learning tasks, Concept Learning as search, Find S algorithm, Version Spaces and Candidate Elimination algorithm. **Machine Learning Project:** Working with real data, Explore and visualize the data, Prepare the data for Machine Learning, Select and train the model, Fine tune the model, Launch and maintain the system, MNIST, Training a binary classifier, Performance measures, Multiclass Classification, Error Analysis, Multilabel classification, Multioutput classification.	**10 Hours**

MODULE - IV

Support Vector Machine, Decision Tree and Random Forest: Linear SVM classification, Nonlinear SVM classification, SVM Regression, Decision Tree representation, Appropriate problems for Decision Tree learning, Basic Decision Tree learning algorithm, voting classifiers, Bagging and Pasting, Random Forests, Boosting, Stacking **Generative AI and Agentic systems:** Introduction to NLP, GANs, Introduction to transformer models, Introduction to LLMs, Introduction to Agentic AI.	**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 understanding of AI and its foundations in search techniques	CL3
CO2	Apply the game playing and logic concepts in AI	CL3
CO3	Demonstrate the concepts of Machine Learning and Concept Learning and Examine the usage of machine learning algorithms with real-world datasets.	CL2
CO4	Apply various machine learning algorithms for classification problems and understand foundations of Generative AI principles	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			
CO2	3	3	2					2				2			
CO3	3	3	3					2				2			
CO4	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	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. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. Artificial Intelligence, Saroj Kaushik, Cengage Learning India Pvt Limited, Second Edition
3. Aurelien Geron, Hands-on Machine Learning with Scikit-Learn & TensorFlow, O'Reilly Media Publications, 3rd Edition, 2022, ISBN: 978-93-5542-198-2
4. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
5. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.
6. Elaine Rich and Kevin Knight, Artificial Intelligence, Tata McGraw Hill Publications, 3rd Edition, 2019, ISBN: 9780070087705

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

1. https://www.coursera.org/learn/machine-learning
2. https://www.coursera.org/learn/ibm-unsupervised-machine-learning
3. https://www.coursera.org/learn/introduction-to-ai
4. Google Generative AI Course - https://www.cloudskillsboost.google/paths/118

EMBEDDED SYSTEM PROGRAMMING
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	**BRA506E2**	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 microcontroller hardware features.
- Microcontroller basic programming using C/C++.
- Overall knowledge of computer architecture.

COURSE OBJECTIVES:

- Introduce fundamentals of embedded systems, their architecture, and the role of programming in resource-constrained environments.
- Develop proficiency in using low-level programming (C/C/C++/Assembly) for embedded systems with emphasis on efficiency and reliability.
- Familiarize students with microcontrollers, peripherals, interfacing techniques, and real-time constraints.
- Enable students to design, implement, and test embedded applications considering performance, power consumption, and memory 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 Embedded System: Architecture, Computing Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface: Analog & Digital, Timers, Embedded Firmware, Quality Attributes of Embedded Systems.	**10 Hours**

MODULE - II

Embedded I/O & Memory: Different approaches of I/O operation: Polling, Interrupt, DMA, Interrupt & DMA Controllers, Memory controller, Communication Protocols features & functioning: I2C, SPI, USB, Ethernet,Wi-Fi, Bluetooth. **Embedded Firmware Development**: Embedded Firmware Design Approaches, Programming in Embedded C: Examples with GPIO, PWM, ADC, UART, I2C,SPI	**10 Hours**

MODULE - III

Real-Time Operating System (RTOS) based Embedded System Design: Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking Task Scheduling, Threads, Processes and Scheduling: Task Communication, Task Synchronization, Writing Device Drivers, How to Choose an RTOS.	**10 Hours**

MODULE - IV

The Embedded System Development Environment: The Integrated Development Environment (IDE), Types of Files Generated on Cross-compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging.	**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 functioning and features of processors, memory and I/O systems in developing embedded system.	CL3
CO2	Analyze the embedded OS functionality and device drivers used in multitasking embedded applications.	CL4
CO3	Design embedded applications using given specifications and concepts of communication protocols and modules.	CL2
CO4	Demonstrate practical experiments on developing embedded 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					2				2			
CO2	3	3	2					2				2			
CO3	3	3	3					2				2			
CO4	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	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. Introduction to Embedded Systems, Shibu K V, Tata McGraw Hill Education Private Limited, 2009
2. Embedded System Design: A Unified Hardware/Software Introduction, Frank Vahid& Tony Givargis, Wiley Publication, 2006
3. Embedded Systems – A contemporary Design Tool, James K Peckol, John Weily, 2008.
4. Computer Organization & Embedded System, Carl Hamacher, NaraigManjikian, McGraw Hill Publication 2014.

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

1. https://electrovolt.ir/wp-content/uploads/2018/04/Programming-with-Stm32-Getting- Started-with-the-Nucleo.pdf
2. http://www.multimedialab.be/doc/erg/2018-2019/Raspberry_Pi/Raspberry_Pi_The_Complete_Manual_8th_Ed_2016.pdf

MODEL-BASED SYSTEMS ENGINEERING
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	BRA506E3	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 Systems Engineering and the role it plays in design and manufacturing.

COURSE OBJECTIVES:

- To expand and improve the application of model-based systems engineering in their field.
- Student implements model-based systems engineering practices in their field that result in higher levels of value and satisfaction with engineered systems.
- Student pursues further in-depth education and training in systems 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
- Case Studies

COURSE CONTENTS

MODULE - I	
Introduction to Model-Based Systems Engineering (MBSE): Review of the INCOSE Systems Engineering Lifecycles and Technical Processes, basic concepts of MBSE, The Business Case for MBSE, Introduction to MBSE Tool, **Creating Requirements:** Writing Good Requirements, Eliciting Requirements, Capture Originating Requirements, Requirement Types and Characterization, Writing Constraints and Performance Requirements Creating and Organizing Requirements in the MBSE tool.	**10 Hours**
MODULE - II	
Requirements Modeling, Analysis, and Management: Requirement Relationships in MBSE, Requirements Visualization: Requirements Diagram, Traceability Hierarchy Diagram, Creating and Handling Requirement Risks and Concerns, Requirements Management.	**10 Hours**
MODULE - III	
Define the System Context and Boundary: Define the Physical Context, Environmental Characteristics as Components, Use of Diagrams and SysML: Structure Block Diagram, Component Hierarchy Diagram. **Define the System Behavior:** Behavior Constructs, Functions and Functional Hierarchy, States/Modes Use Cases and Threads, Other Types of Behavior Diagrams: Activity, FFBD/EFFBD, N2 Diagrams, Sequence Use of Folders to Organize Work.	**10 Hours**
MODULE - IV	
Advanced System Behavior Modeling: Integrated Systems Behavior, Functional Traceability and Model Relationships: Functions to Use Cases to Requirements, Performing Functional Decomposition, Capture Functional and Performance Concerns and Risks Capturing Behavior with SysML. **Failure Modes and Effect Analysis (FMEA):** Basics of FMEA, Application of FMEA in Model-Based Systems Engineering.	**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 INCOSE Systems Engineering lifecycle and the fundamental principles, tools, and benefits of Model-Based Systems Engineering.	CL2
CO2	Develop, organize, and manage various types of system requirements using MBSE tools, including capturing requirement relationships, constraints, and traceability.	CL3
CO3	Model and analyze system structure and behavior using SysML diagrams, including block diagrams, activity diagrams, sequence diagrams, and FFBDs.	CL4
CO4	Integrate advanced system behavior models with requirements, perform functional decomposition, and apply FMEA to identify and mitigate potential system failures in an MBSE environment.	CL5

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	1			2			2			
CO2	3	3	2		3				2		2	2			
CO3	3	3	3	2	3				2	1	2	2			
CO4	3	3	3	3	3	2	1	2	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**
	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. Friedenthal, Moore, and Steiner. A Practical Guide to SysML, 3rd Edition: The Systems Modeling Language. The MK/OMG Press. 2012. ISBN-13: 978-0128002025.
2. M. Ryan and L. Wheatcraft, Guide for Writing Requirements, INCOSE Technical Product INCOSE-TP-2010-006-02, 1 July 2015.
3. Buede, Dennis and William D. Miller. The Engineering Design of Systems: Models and Methods, 3rd Edition. Wiley. ISBN: 978-1-119-02790-4.
4. Berenbach, Paulish, Kazmeier, Rudorfer. Software and Systems Requirements Engineering in Practice. 2009. ISBN: 978-0-07-160547-2

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

1. https://www.coursera.org/learn/mbse
2. https://onlinecourses.nptel.ac.in/noc21_mg39/preview

SOFT ROBOTICS
(Effective from the Academic Year 2024 - 2025)
V SEMESTER

Course Code	BRA506E4	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 sensors and actuators

COURSE OBJECTIVES:

- To introduce the concept of soft robotics, its bio-inspired design principles, and materials used in fabrication.
- To explore various soft actuation mechanisms including cable-driven, fluidic, and smart material-based systems.
- To study variable stiffness structures and control strategies for designing functional soft robots.
- To understand soft robot architectures, bio-inspiration principles, and soft sensing techniques.

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 soft robotics: Definitions and Applications. Morphological computation and Bio inspired design. **Materials for soft robotics**: Elastomers, Thermoplastics and textiles, Advanced materials	**10 Hours**

MODULE - II

Soft Actuation: Cable driven soft robots, Fluidic actuation, Dielectric elastomers, Shape memory alloys, Additional actuation strategies	**10 Hours**

MODULE - III

Variable Stiffness mechanisms: Introduction to variable stiffness structures Jamming mechanisms **Design and control of soft robots:** Typical soft robot architectures On-board powering, On-board control	**10 Hours**

MODULE - IV

Structural Difference between Hard and Soft Robots, Bio-inspiration in Soft Robotics, Hydrostatic Skeletons, Muscular Hydrostats, Soft Active Plant Structure, Soft Robots, Actuators, Pneumatic Artificial Muscles, Electroactive Polymers. **Soft electronics and soft sensing:** How to embed sensing capabilities and conductive elements in soft structures Soft resistive, capacitive, and inductive sensing, Soft optical and ionic sensing	**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 fundamentals of soft robotics, including bio-inspired design and selection of materials like elastomers and thermoplastics.	CL3

CO2	Analyze and compare different soft actuation methods such as cable-driven, fluidic, and shape memory-based actuators.	CL3
CO3	Design soft robot structures with variable stiffness and implement control strategies for onboard power and actuation.	CL3
CO4	Evaluate structural and functional differences between hard and soft robots, and apply soft sensing and electronics techniques in soft robotic 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					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. Soft Robotics: Trends, Applications and Challenges: Proceedings of the Soft Robotics Week, April 25-30, 2016, Livorno, Italy (Biosystems & Biorobotics Book 17) 1st ed. 2017 Edition, Kindle Edition
2. Soft Robotics Editor: Gareth J. Monkman Year of Publication: 2022
3. Soft Robotics by Matthew Borgatti

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

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 — **4 Hours**

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.

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	BRA601T	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/

ADVANCED RISC MACHINES
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA602G**	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 Electronic Circuits and Programming Concepts

COURSE OBJECTIVES:

- To introduce the RISC and ARM design philosophies, and to develop a foundational understanding of embedded system hardware and software components along with ARM processor fundamentals
- To enable students to interpret and apply the ARM instruction set architecture
- To impart knowledge of ARM exception and interrupt mechanisms
- To provide a detailed understanding of memory hierarchy and cache architecture in ARM 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

ARM Embedded Systems: The RISC design philosophy, The ARM Design Philosophy, Embedded System Hardware, Embedded System Software. **ARM Processor Fundamentals:** Registers, Current Program Status Register, Pipeline, Exceptions, Interrupts, and the Vector Table, Core Extensions	**10 Hours**

MODULE - II

Introduction to the ARM Instruction Set: Data Processing Instructions, Branch Instructions, Software Interrupt Instructions, Program Status Register Instructions, Coprocessor Instructions, Loading Constants. **Compilers and Optimization:** Basic C Data Types, C Looping Structures, Register Allocation, Function Calls, Pointer Aliasing, Portability Issues.	**10 Hours**

MODULE - III

Exception and Interrupt Handling: Exception handling, ARM processor exceptions and modes, vector table, exception priorities, link register offsets, interrupts, assigning interrupts, interrupt latency, IRQ and FIQ exceptions, basic interrupt stack design and implementation. **Firmware:** Firmware and bootloader, ARM firmware suite, Red Hat redboot, Example: sandstone, sandstone directory layout, sandstone code structure.	**10 Hours**

MODULE - IV

CACHES: The Memory Hierarchy and Cache Memory, Caches and Memory Management Units: CACHE Architecture: Basic Architecture of a Cache Memory, Basic Operation of a Cache Controller, The Relationship between Cache and Main Memory, Set Associativity, Write Buffers, Measuring Cache Efficiency, CACHE POLICY: Write Policy—Writeback or Writethrough, Cache Line Replacement Policies, Allocation Policy on a Cache Miss. Coprocessor 15 and caches.	**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 RISC and ARM design philosophies to analyze the structure and function of embedded system hardware and software components.	CL3
CO2	Implement ARM processor programming using data processing, branching, and exception handling instructions in assembly and C.	CL3
CO3	Apply interrupt and exception handling mechanisms on ARM architecture to design responsive embedded systems with proper stack and mode control.	CL3
CO4	Use cache memory architecture concepts and Coprocessor 15 features to improve memory access efficiency in ARM-based embedded systems.	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Using Keil software, observe the various Registers, Dump, CPSR, with a simple Assembly Language Programs (ALP).	CO1	CL3
2.	Develop and simulate ARM ALP for Data Transfer, Arithmetic and Logical operations (Demonstrate with the help of a suitable program).	CO2	CL3
3.	Develop an ALP to multiply two 16-bit binary numbers.	CO2	CL3
4.	Develop an ALP to find the sum of first 10 integer numbers.	CO2	CL3
5.	Develop an ALP to find the largest/smallest number in an array of 32 numbers.	CO2	CL3
6.	Develop an ALP to count the number of ones and zeros in two consecutive memory locations.	CO2	CL3
7.	Simulate a program in C for ARM microcontroller using KEIL to sort the numbers in ascending/descending order using bubble sort.	CO3	CL3
8.	Simulate a program in C for ARM microcontroller to find factorial of a number.	CO3	CL2
9.	Simulate a program in C for ARM microcontroller to demonstrate case conversion of characters from upper to lowercase and lower to uppercase.	CO3	CL3
10.	Demonstrate enabling and disabling of Interrupts in ARM.	CO4	CL3
11.	Demonstrate the handling of divide by zero, Invalid Operation and Overflow exceptions in ARM.	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	3	3	2		2			2	1			1	3		
CO2	2	2	1		2			2	1			1	3		
CO3	3	2	2		2			2	1			1	3		
CO4	3	3	1		2			2	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. ARM system developers guide, Andrew N Sloss, Dominic Symes and Chris Wright, Elsevier, Morgan Kaufman Publishers, 2008.
2. Microcontroller (ARM) and Embedded System, Raghunandan. G. H., Cengage learning Publication, 2019.
3. Insider's Guide to the ARM7 based microcontrollers, Hitex Ltd.,1st edition, 2005.

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

1. https://www.youtube.com/watch?v=UdY5RkkT7bg

ROBOT DESIGN
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	BRA603T	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 and bevel gears.
- To understand the design formulation of 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

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.	**10 Hours**

MODULE - II

Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Concentric springs; springs under fluctuating loads. **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-length & cross section. **Wire ropes:** Construction of wire ropes, stresses in wire ropes, and selection of wire ropes.	**10 Hours**

MODULE - III

Spur Gears: Definitions, stresses in gear tooth, Lewis equation and form factor, design for strength, dynamic load and wear. **Bevel Gears:** Definitions, formative number of teeth, design based on strength, dynamic load and wear.	**10 Hours**

MODULE - IV

Permanent Joints: Design of Welded joints, Types, strength of butt and fillet welds, eccentrically loaded welded joints. **Lubrication and 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**

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 behavior of machine members under axial, bending, shear, and torsional loads.	CL4
CO2	Analyze the mechanical behavior of springs, belts, and wire ropes under various loading and operational conditions.	CL4
CO3	Analyze the design of spur and bevel gears by evaluating material selection, and load conditions using strength, dynamic, and wear considerations.	CL4
CO4	Analyze the strength of the weld joint under various loading conditions and pressure development, friction, and thermal aspects of the bearings.	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/

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

COMPUTER VISION AND DEEP LEARNING

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BRA604E1**	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 programming
- Understanding of statistics, linear algebra, Probability and Calculus

COURSE OBJECTIVES:

- Understand the importance, principles, and search methods of AI
- Provide knowledge on predicate logic.
- Introduce machine learning fundamentals
- Study of supervised learning algorithms.
- Study about unsupervised learning algorithms.

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	
Vision Fundamentals and Image Formation - Image Formation and Early Image-Processing Operations, Introduction to modern computer vision, Robotic Perception and Robot Hardware, Using Vision in robotics applications. **Basic Image Processing** - Low-level vision operations, Spatial and frequency domain filtering, Edge detection and Line detection, Introduction to feature detection concepts.	**10 Hours**
MODULE - II	
Advanced Feature Detection - Harris corner detector and Blob detection, SIFT (Scale-Invariant Feature Transform),Feature descriptors and SURF, Histogram of Oriented Gradients (HoGs). **Geometric Vision and Object Recognition**- Camera intrinsics and extrensics, Single-view geometry and Two-view stereo, Algebraic representation of epipolar geometry, 2D Geometric transformations, Object Recognition by Appearance and Structural Information, Reconstructing the 3D World, Introduction to mid-level and high-level vision.	**10 Hours**
MODULE - III	
Neural Network Basics -Introduction to deep learning and neurons, Multilayer perceptron (MLP) architecture, Training neural networks and Gradient descent, Backpropagation in MLP. **Optimization and Learning** - Regression and Classification losses, Optimization techniques and regularization, Regularization methods and preprocessing, best practices for neural network training.	**10 Hours**
MODULE - IV	
Convolutional Neural Networks-CNN fundamentals and properties, CNN architectures and design principles, Applications in computer vision tasks. **Sequential and Advanced Models-** Introduction to Recurrent Neural Networks (RNN), Encoder-Decoder models in RNN, Integration of CNN and RNN for robotics 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 fundamental computer vision principles and image processing techniques to solve robotic perception problems.	CL3
CO2	Execute feature detection algorithms and geometric transformations to develop complete 3D vision systems for robotic applications.	CL3
CO3	Implement neural network architectures and optimization algorithms to develop deep learning solutions for computer vision tasks.	CL3
CO4	Construct and deploy convolutional and recurrent neural network models for advanced computer vision applications in robotics.	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. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. Artificial Intelligence, Saroj Kaushik, Cengage Learning India Pvt Limited, Second Edition
3. Aurelien Geron, Hands-on Machine Learning with Scikit-Learn & TensorFlow, O'Reilly Media Publications, 3rd Edition, 2022, ISBN: 978-93-5542-198-2
4. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
5. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.
6. Elaine Rich and Kevin Knight, Artificial Intelligence, Tata McGraw Hill Publications, 3rd Edition, 2019, ISBN: 9780070087705
7. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer Nature, 2010.
8. Computer Vision: Models, Learning, and Inference, Simon J.D. Prince, 2012.
9. Computer Vision: A Modern Approach, David Forsyth, Jean Ponce,2011.

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

1. https://www.coursera.org/learn/machine-learning
2. https://www.coursera.org/learn/ibm-unsupervised-machine-learning
3. https://www.coursera.org/learn/introduction-to-ai
4. EE5178 Mordern Computer Vision Prof.A.N.Rajagopalan - https://onlinecourses.nptel.ac.in/noc23_ee78/preview
5. https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

CLOUD COMPUTING AND FOG COMPUTING

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**BRA604E2**	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:

- Coding skills
- Hardware and software architecture
- Software engineering concepts
- Virtualization technologies

COURSE OBJECTIVES:

- Discuss the concepts, characteristics, delivery models and benefits of cloud computing.
- Explore the key technical, organisational and compliance challenges of cloud computing.
- Grasp the concepts of virtualization efficiently.
- Explore the security issues that arise from cloud computing architectures intended for delivering Cloud based enterprise IT services.

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, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Opensource software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.	**10 Hours**
MODULE - II	
Cloud Computing: Application Paradigms.: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre The Web application, Cloud for science and engineering, Highperformance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.	**10 Hours**
MODULE - III	
Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization, Exercises and problems	**10 Hours**
MODULE – IV	
Cloud Security and Application Development: Cloud security risks, Privacy and trust management, Virtual machine security, Security risks posed by shared images and management OS, Security of virtualization, Amazon Web Services: EC2 instances, Security rules for application and transport layer protocols, How to	**10 Hours**

launch an EC2 Linux instance and connect to it, How to use S3 in Java/Python, Cloud-based adaptive data streaming service, Exercises and problems.
Fog Computing: Fog and cloud architecture, Fog resource allocation and task scheduling, Latency-aware applications, Security issues in fog environments, IoT–Fog–Cloud continuum: smart cities, healthcare, and industry 4.0 case studies, Exercises and problems.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Compare the strengths and limitations of cloud computing	CL3
CO2	Identify the architecture, infrastructure and delivery models of cloud computing	CL3
CO3	Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service	CL3
CO4	Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services	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	1		
CO2	3	3	2					2				2	1		
CO3	3	3	3					2				2	1		
CO4	3	3	3					2				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)	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. Cloud Computing Implementation, Management and Security John W Rittinghouse, James F Ransome, CRC Press, 2013.
2. Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton, Publication, November 2, 2009
3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, ISBN-10: 0596802765, O'Reilly Media, September 2009
4. Cloud Computing: Theory and Practice, Dan C Marinescu Elsevier (MK), 2013
5. Computing Principles and Paradigms, RajkumarBuyya , James Broberg, Andrzej Goscinski Willey, 2014

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

1. https://www.javatpoint.com/cloud-computing-tutorial
2. https://www.tutorialspoint.com/cloud_computing/index.html
3. https://www.digimat.in/nptel/courses/video/106105167/L01.html

Principles of Industry 5.0
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA604E3**	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 Industry 4. 0.

COURSE OBJECTIVES:

- To acquaint with the digital transformation of Industry 5.0
- To recognize the power of industry to achieve societal goals beyond jobs and growth
- To understand the design of personalized electronics products
- To focus on methods of interaction between humans and machines in virtual reality
- To develop the concept of augmented reality in electronics manufacturing beyond automation and optimization.

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 from Industry 1.0 to 5.0, Introduction to Industry 5.0, Globalization and Emerging Issues, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories,Human computer interactions, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management and Big Data	**10 Hours**

MODULE - II

DIGITAL TRANSFORMATION TO INDUSTRY 5.0: Digital Transformation, Introduction to Digital Transformation, Digital business transformation, Causes of disruption and transformation, Digital transformation myths and realities, Digital transformation across various industries, Retail industry, Urban Development, e-Governance and the public sector, Insurance industry, Healthcare, Food, Manufacturing, Disaster Control, Elements of Society 5.0, Data Driven to Society, Humanity Vs Society 5.0.	**10 Hours**

MODULE - III

SMART WORLD: Introduction: Sensing & actuation, Communication, Electronics in Smart city, 5G Technology, Communication protocols, Integration of Sensors in Robots and Artificial Intelligence, Human-Machine Interaction, Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management., Intellectual Property Rights- Case Studies - Milk Processing and Packaging Industries	**10 Hours**

MODULE - IV

CYBER SECURITY IN INDUSTRY 5.0: Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, Networking systems for CPS applications, Wearable cyber physical systems and	**10 Hours**

applications, **AR/VR IN INDUSTRY 5.0:** Unity, Basics of Unity, understanding different panels in Unity, Moving, rotating & scaling Game objects in Unity, Game Panel in Unity, Physics in Unity, Increasing the light intensity, Adding colors to Game object, Adding textures to Game object, Parent and child Game objects in Unity.	

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 digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth	CL3
CO2	Analyze enhanced new production models in electronics	CL3
CO3	Implement various electronics manufacturing technologies of augmented reality beyond automation and optimization	CL3
CO4	Evaluate the performance of various cyber physical systems, AR and VR in Industry 5.0.	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	1	3		2	1	2			3	1	1	2
CO2	3	2	2	1	3		2	1	2			3	1	1	2
CO3	3	2	2	1	3		2	1	2			3	1	1	2
CO4	3	2	2	1	3		2	1	2			3	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
	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. Industry 5.0 The Future of the Industrial Economy,Uthayan Elangovan, 1st Edition, CRC Press.
2. Enabling Technologies for Industry 5.0, Results of a workshop with Europe's technology leaders, (2020).
3. "Manufacturing the Future Workforce." Collier, I., & Shakspeare P. (2020)

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

COGNITIVE COMPUTING FOR ROBOTICS AND AUTOMATION
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA604E4**	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 Computing

COURSE OBJECTIVES:

- To introduce intelligent system design principles, cognitive development, and machine perception techniques.
- To explore the design and control of intelligent agents using neural networks, fuzzy logic, and nature-inspired algorithms.
- To provide an understanding of robot map building, path planning, and SLAM techniques.
- To develop hands-on programming skills in autonomous robot control using Python and related software tools.

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- Intelligent System Design and Cognition Development, Thinking, Cognition, and Intelligence, Defining Intelligence - Embodiment and Its Implications, Synthetic Methodology for Intelligence. **Introduction to the Model of Cognition**, Visual Perception, Visual Recognition, Machine Learning, and Robot Cognition.	**10 Hours**

MODULE - II

Intelligent System Design, Cognition Development and control: Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, Matching brain and Body Dynamics, Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN.	**10 Hours**

MODULE - III

Map Building: Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Map Building. **Randomized Path Planning:** Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, planning with moving obstacles, Probabilistic Roadmaps, rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program. **Simultaneous Localization and Mapping (SLAM): Problem** Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms.	**10 Hours**

MODULE - IV	
Robot Programming methods: Python Robot Programming Methods-: Go-to-Goal Behavior, Avoid-Obstacles Behavior, Hybrid Automata (Behavior State Machine), Follow-Wall Behavior. A Complete Program for autonomous mobile robot. Robot Programming Packages: Robot Parameter Display, Program for BotSpeak, Program for Sonar Reading Display, Program for Wandering Within the Workspace, Program for Tele-operation.	**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 principles of cognition and intelligence in intelligent systems and apply foundational models of visual perception and machine learning	CL3
CO2	Design intelligent agents using ANN, fuzzy logic, and genetic algorithms, and analyze their role in cognition and control	CL3
CO3	Apply algorithms for 2D map building, path planning, and SLAM using techniques such as EKF, PRM, and RRT	CL2
CO4	Implement autonomous robot behaviors using Python and develop functional robotic programs for navigation and interaction	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			
CO2	3	3	2					2				2			
CO3	3	3	3					2				2			
CO4	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	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. HoomanSomani," Cognitive Robotics", CRC Press, 2015
2. Jared Kroff," Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016

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

1. https://www.toptal.com/robotics/programming-a-robot-an-introductory-tutorial

INTRODUCTION TO ROBOTICS
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA605Q1**	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, four 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	
Robots 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

INTRODUCTION TO CYBER PHYSICAL SYSTEMS

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	**BRA605Q2**	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 Robotics

COURSE OBJECTIVES:

- Understand Cyber Physical System
- Analyse Intelligent CPS
- Apply modern tools to develop CPS applications
- To learn about design of cyber-physical 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

Fundamentals of CPS : Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS **CPS HW platforms:** Processors, Sensors, Actuators, CPS Network, CPS SW stack RTOS, Scheduling Real Time control tasks.	**10 Hours**

MODULE – II

Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques. **Stability Analysis:** CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise. **CPS:** From features to software components, Mapping software components to ECUs, CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion	**10 Hours**

MODULE – III

Formal Methods for Safety Assurance of Cyber-Physical Systems: Advanced Automata based modelling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, zenoness, Formal Analysis: Flow pipe construction, reachability analysis, Analysis of CPS Software, Weakest Pre-conditions, Bounded Model checking	**10 Hours**

MODULE - IV

Hybrid Automata Modelling: Flowpipe construction using Flowstar, SpaceX and Phaver tools, CPS SW Verification: Frama-C, CBMC, **Secure Deployment of CPS:** Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Automotive.	**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 basic principles of design and validation of CPS and CPS HW platforms.	CL3
CO2	Demonstrate the Principles of Automated Control Design and Stability Analysis.	CL3
CO3	Explain the Mapping software components to ECUs and CPS Performance Analysis and classify the Formal Methods for Safety Assurance of Cyber-Physical Systems.	CL3
CO4	Understand the Hybrid Automata Modelling and Secure Deployment of CPS.	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		3	
CO2	3	3	2					2		2		3		3	
CO3	3	3	2					2		2		3		3	
CO4	3	3	2					2		2		3		3	
CO5	3	3	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
		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. E. A. Lee and S. A. Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2011.
2. R. Alur, “Principles of Cyber-Physical Systems,” MIT Press, 2015.
3. T. D. Lewis “Network Science: Theory and Applications”, Wiley, 2009.
4. P. Tabuada, “Verification and control of hybrid systems: a symbolic approach”, Springer-Verlag 2009.
5. C. Cassandras, S. Lafortune, “Introduction to Discrete Event Systems”, Springer 2007.
6. Constance Heitmeyer and Dino Mandrioli, “Formal methods for real-time computing”, Wiley publisher, 1996.

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

1. https://onlinecourses.nptel.ac.in/noc23_cs62/preview

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

INTRODUCTION TO AUTOMATION

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**BRA605Q3**	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 CAD and Mechatronics

COURSE OBJECTIVES:

- To familiarize students with the basic elements, functions, and levels of automation, and to introduce key hardware components used in process control.
- To introduce the structure and application of automated production lines and identification systems used in industrial manufacturing.
- To develop knowledge of PLC hardware, programming techniques, and ladder logic construction using timers, counters, and control instructions.
- To enable students to design and apply various operational function blocks in ladder logic and to understand the fundamentals of SCADA 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 automation: Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data.	**10 Hours**
MODULE - II	
Automated production lines: Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies.	**10 Hours**
MODULE - III	
PLC Hardware & Programming Types of Programming, construction of PLC ladder diagrams, Controlling Program Flow in a Ladder Logic Program. Various Types of Addressing Used within a PLC, PLC Programming input instructions, Timers and Counters: What are timers & Counters, Use of timers and counters within a ladder logic program, Basic concepts of function blocks.	**10 Hours**
MODULE - IV	
Different operational blocks Math block, Logical block, Compare block, Sequential & Shift, Program block, Control block, Ladder design of math, logical and compare functions, Ladder design of sequential & shift functions, Ladders design of program functions, Ladder design of control functions. **Introduction to SCADA** Introduction and SCADA Basics. Importance of SCADA in Industrial Automation, Basic operation of SCADA-Basic window property concepts of SCADA	**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 concepts of automation and process control, including hardware components like sensors, actuators, and converters.	CL3
CO2	Use automated production line principles and identification technologies such as barcodes and RFID to analyze manufacturing operations.	CL3
CO3	Construct PLC ladder logic programs using timers, counters, and control instructions for automation tasks.	CL3
CO4	Implement mathematical, logical, and control function blocks using ladder logic, and demonstrate the basic features of SCADA 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	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:

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

INTRODUCTION TO ROBOT OPERATING SYSTEM

(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA605Q4**	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 programming, basic robotics concepts, and an understanding of operating system principles.

COURSE OBJECTIVES:

- Understand the fundamental concepts of Robot Operating Systems
- Develop ROS2 Packages for real time applications
- Develop real time robotic projects using ROS2

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

ROS2 Overview: The ROS Community, The Computation Graph, the workspace. The ROS2 design. **CLI tools**: Configuring environment, Using turtlesim, ros2 and rqt, Understanding nodes, topics, services, parameters, actions, Using rqt_console to view logs, Launching nodes, Recording and playing back data.	**10 Hours**

MODULE - II

Client libraries: Using COLCON to build packages, Creating a workspace, Creating a package, Writing a simple publisher and subscriber, Writing a simple service and client, Creating custom msg and srv files, Implementing custom interfaces, Using parameters in a class, Using ros2doctor to identify issues.	**10 Hours**

MODULE - III

Intermediate ROS2: Managing Dependencies with rosdep, Creating an action, Writing an action server and client, Composing multiple nodes in a single process, Monitoring for parameter changes, Launch, tf2, Testing, URDF, Using Fast DDS Discovery Server as discovery protocol,	**10 Hours**

Implementing a custom memory allocator, Unlocking the potential of Fast DDS middleware.	
MODULE - IV	
Advanced ROS2 : Recording a bag from a node, Reading from a bag file, Simulators- Gazebo and Webots, Security, Using quality-of-service settings for lossy networks, Managing nodes with managed lifecycles, Setting up efficient intra-process communication, Recording and playing back data with rosbag using the ROS2 bridge, Understanding real-time programming, Experimenting with a dummy robot, Logging, Creating a content filtering subscription, External resources.	**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 knowledge of ROS2 computation graph components, CLI tools, and workspace configuration to effectively utilize nodes, topics, services, parameters, actions, and logging for robotic applications.	CL2
CO2	Demonstrate proficiency in using colcon to build packages, creating workspaces and packages.	CL3
CO3	Employ ROS2 concepts, such as managing dependencies with rosdep and conducting testing and URDF implementation for enhanced robotic system development.	CL3
CO4	Implement advanced ROS2 features by utilizing the Fast DDS Discovery Server, custom memory allocators, simulators (Gazebo and Webots), and addressing security, Apply QoS settings, experiment with a dummy robot.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	ROS2 Installation and Workspace Setup	CO1	CL2
2.	Creating Your First ROS2 Package	CO1	CL2
3.	Writing a Simple Publisher and Subscriber node	CO1	CL2
4.	Understanding and creating ROS2 Nodes and RCLCPP/RCLPY	CO2	CL3
5.	Exploring ROS2 CLI Tools	CO2	CL3
6.	Implementing ROS2 Services	CO2	CL3
7.	Using ROS2 Parameters	CO3	CL3
8.	Understanding ROS2 Launch System	CO3	CL3
9.	ROS2 Lifecycle Nodes	CO4	CL4
10.	Exploring ROS2 TF and URDF	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							1		1		3	
CO2	3	3	3							1		1		3	
CO3	3	3	3						1	1		1		3	
CO4	3	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
2	Semester End Examination (SEE)	100 %	50

ASSESSMENT DETAILS

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

NOTE:

- Assessment will be both CIA and 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:

REFERENCE BOOKS:

1. ROS2 Humble documentation - https://docs.ros.org/en/humble/index.html
2. Rico, F. M. (2022). A concise introduction to robot programming with ROS2. CRC Press.

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

1. https://youtu.be/a6_fgnuuYfE?si=TRzS1yjnFichQIFE
2. https://youtu.be/rYWJdZ5qg6M?si=czdIG-3E_evynU3h
3. https://youtu.be/j0kmlMDcObE?si=t0s9cSpvp-lLv0WU
4. https://docs.ros.org/en/humble/Tutorials.html

CNC AND 3D PRINTING LAB
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA607L**	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 CNC Programming
- Knowledge of Rapid Prototyping

COURSE OBJECTIVES:

- Expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
- Give students a knowledge on using CAM packages.
- Learn the selection of material, equipment and development of a product for Industry 4.0 environment.
- Educate students on application & integration of CAD and CAM packages.
- 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
- 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 CNC part programming with G&M codes for 5 Turning programs. Selection and assignment of tools, correction of syntax and logical errors. Verification of tool path using CNC program verification software.
2	Simulation of Turning operation using any program generation software such as Cadem CAM Lab-Pro, Master CAM, EDGE CAM etc.
3	Manual CNC part programming with G&M codes for 5 Milling programs. Selection and assignment of tools, correction of syntax and logical errors. Verification of tool path using CNC program verification software.
4	Simulation of Milling operation using any program generation software such as Cadem CAM Lab-Pro, Master CAM, EDGE CAM etc.
5	3D Modelling and assembly of a single component. Exercise on CAD Data Exchange (optional)
6	Generation of .stl files. Identification of a product for Additive Manufacturing and generation of its process plan.
7	Printing of identified products on an FDM AM machine.
8	Printing of identified products on an SLA AM machine.
9	Post processing of additively manufactured products (micro machining, cavity cleaning and some secondary operations).

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 manually program CNC machines using G&M codes for both turning and milling operations	CL3
CO2	Exhibit competency in verifying tool paths using CNC program verification software	CL3
CO3	Simulate machining processes, gaining practical experience in virtually visualizing and refining machining operations before actual execution.	CL3
CO4	Develop 3D models and assemblies for a single component using CAD software	CL3
CO5	Demonstrate post-processing skills for additively manufactured products, including micro-machining, cavity cleaning, and performing secondary 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	1
CO2	3	2			3							2		2	1
CO3	3	2			3							2		2	1
CO4	3	2			3							2		2	1
CO5	3	2			3							2		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**
	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. P N Rao: CAD/CAM: Principles and Applications, 3 rd Edition, Tata McGraw-Hill Publishing Company limited, 2017.
2. Radhakrishnan P: Computer Numerical Control Machines, New Central Book Agency, 2002.
3. M Groover, E Zimmer: CAD/CAM, Pearson, 2014.
4. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World
5. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
6. Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press. Scientific.

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

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/

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

Course Code	**BRA608A1**	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" .
- Preperatory knowledge of Pytorch, Scikit and Tensorflow.

COURSE OBJECTIVES:

- This course will enable students to (i) Understand and implement the concepts of Artificial Intelligence and Machine Learning. (ii) 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.

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.	CL4
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.	CL4
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.	CL4
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.	CL4
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.	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		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:

- "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
- "Deep Learning with Python" by François Chollet
- "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- "PyTorch Deep Learning Hands-On" by Sherin Thomas and Sudhanshu Passi
- "Learning TensorFlow: A Guide to Building Deep Learning Systems" by Tom Hope, Yehezkel S. Resheff, and Itay Lieder

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

STRUCTURAL SIMULATION LAB
(Effective from the Academic Year 2024 - 2025)
IV SEMESTER

Course Code		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 Finite Element Methods, Solid works, Mechanics of Materials.

COURSE OBJECTIVES:

- Understand the fundamentals of Finite Element Analysis (FEA) and its role in mechanical design.
- Model real-life mechanical components and structural elements using simulation tools.
- Apply appropriate boundary conditions and loads to simulate physical behavior.
- Analyze stress, strain, deformation, thermal effects, buckling, and vibration responses.
- Validate and interpret simulation results for decision-making in engineering 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	Static Structural Analysis of a Cantilever Beam, simply supported beam.
2	Structural Analysis of a Mechanical Bracket subjected to Axial, Bending and Torsional loading.
3	Buckling Analysis of a Slender Column
4	Fatigue Life Estimation of a Loaded Component
5	2D Truss Analysis
6	Thermal Stress Analysis of a Plate
7	Modal Analysis of a Machine Component
8	Contact and Assembly Simulation (Ex:Flange/Gear Pair)
9	Topology Optimization of a Mechanical Part

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply FEA tools to simulate mechanical behavior of components under various loads.	CL3
CO2	Perform static, thermal, modal, fatigue, and buckling analysis on mechanical structures.	CL3
CO3	Interpret simulation results and validate them against theoretical/analytical solutions.	CL3
CO4	Develop, modify, and optimize component designs based on simulation insights.	CL3
CO5	Communicate simulation outcomes effectively through reports and presentations.	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				1	1		2	2		
CO2	3	2	2		2				1	1		2	2		
CO3	3	2	2		2				1	1		2	2		
CO4	3	2	2		2				1	1		2	2		
CO5	3	2	2		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 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 Finite Elements in Engineering, T.R. Chandrupatla & A.D. Belegundu, Pearson Education India; 4th edition, 2015.
2. Finite Element Method in Engineering, S.S. Rao, Butterworth-Heinemann, 5th edition, 2010.
3. Practical Finite Element Analysis, Nitin S. Gokhale, Finite To Infinite; 8th edition, 2020.

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

ARM AND EMBEDDED SYSTEMS LAB

(Effective from the Academic Year 2024 - 2025)

III SEMESTER

Course Code	**BRA506E2**	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:

- Basic Knowledge of Mathematics and Embedded Systems, C PROGRAMMING, Microcontrollers, microprocessor.

COURSE OBJECTIVES:

- To introduce the Building Blocks of Embedded System
- To Educate in Various Embedded Development Strategies
- To Introduce Bus Communication in processors, Input/output interfacing.
- To impart knowledge in various processor scheduling algorithms.
- To introduce Basics of Real time operating system and example tutorials to discuss on one real time operating system tool

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	ALP to multiply two 16 bit binary numbers.
2	ALP to find the sum of the first 10 integer numbers.
3	ALP to find the number of O's and 1's in a 32 bit data
4	ALP to find determine whether the given 16 bit is even or odd
5	ALP to write data to RAM
6	Display "Hello world" message using internal UART
7	Interface and Control the speed of a DC Motor.
8	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
9	Interface a DAC and generate Triangular and Square waveforms.
10	Interface a 4x4 keyboard and display the key code on an LCD.
11	Demonstrate the use of an external interrupt to toggle an LED On/Off
12	Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay.

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 instruction set of 32 bit microcontroller ARM Cortex M3, and the software tool required for programming in Assembly and C language.	CL2
CO2	Develop assembly language programs using ARM Cortex M3 for different applications.	CL2
CO3	Interface external devices and VOwith ARM Cortex M3.	CL2
CO4	Develop C language programs and library functions for embedded system applications.	CL2
CO5	Analyze the functions of various peripherals, peripheral registers and power saving modes of ARM Cortex M3	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 (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.

NON DESTRUCTIVE TESTING LAB
(Effective from the Academic Year 2024 - 2025)
VI SEMESTER

Course Code	**BRA608A4**	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 Material Science and Metallurgy

COURSE OBJECTIVES:

- Understand the Principles of NDT Methods
- Develop Practical Skills in NDT Techniques
- Interpret and Analyze Test Results
- Ensure Safety and Standard Compliance
- Apply NDT in Engineering Problem-Solving

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 study about need of Nondestructive testing (NDT).
2	To perform visual test for given sample using visual aid.
3	To perform Dye/Liquid Penetration Test for given sample with visible and fluorescent dye.
4	To study and perform Magnetic Particle test using different methods of magnetization
5	To study and perform Ultrasonic Test for weld sample.
6	To measure thickness using UT machine for given sample
7	To study Radiographic Testing.
8	To study and perform Leak Testing.
9	To study of Eddy Current Test.
10	To study acoustic emission testing and thermography

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 classify various non-destructive testing methods.	CL3
CO2	Analyze different metals and alloys by visual inspection method.	CL3

CO3	Perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test, X- ray	CL3
CO4	Perform non-destructive tests like : Gamma ray radiography, Leak Test, Eddy current test.	CL3
CO5	Demonstrate acoustic emission testing and thermography.	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. Practical Non-destructive Testing – Baldev Raj, T. Jayakumar & M. Thavasimuthu, Norosa Publishing House, New Delhi.
2. Treaties on Non-destructive testing, Vol. 1,2 & 3 Edited by Dr. E.G. Krishnadas Nair, NDT Centre, Hal, Bangalore
3. Non-destructive testing, Warren J. McGonnagle, Gordon Breach, Science Publishers Ltd.
4. Ultrasonic Testing of Materials, J. Krautkramer & Herbert Krautkramer, Narosa Publishing House, New Delhi.
5. Non-destructive testing, R. Hatmshaw.
6. Ultrasonic Methods of Testing Materials, Leszek Filipezynski, Zdzislaw Pawlowski & Jerzywehr, Butterworths, London.

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

INDUSTRIAL INTERNET OF THINGS
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BRA701G**	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:

- 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
- 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 & Architecture: IIoT, difference between IoT and IIoT, Architecture of IIoT, Challenges of IIOT. **IIOT Components:** Fundamentals of Control System, introductions, components, closed loop & open loop system. **Introduction to Sensors (Description and Working principle):** sensor, Types of sensors, working principle of basic Sensors -Ultrasonic Sensor, IR sensor, Temperature and Humidity Sensors (DHT-11). Digital switch, Electro Mechanical switches.	**10 Hours**

MODULE – II

Communication Technologies of IIoT	**10 Hours**

Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID, Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus technology, wireless network communication.	
MODULE – III	
Visualization and Data Types of IIoT: Front-end EDGE devices, Enterprise data for IIoT, Emerging descriptive data standards for IIoT, Cloud data base, Could computing, Fog or Edge computing. Connecting an Arduino/Raspberry pi to the Web: Introduction, setting up the Arduino/Raspberry pi development environment, Options for Internet connectivity with Arduino, Configuring your Arduino/Raspberry pi board for the IoT. **Retrieving Data:** Extraction from Web: Grabbing the content from a web page, sending data on the web, Troubleshooting basic Arduino issues, Types of IoT interaction, Machine to Machine interaction (M2M).	**10 Hours**
MODULE – IV	
FUNDAMENTALS OF IoT SECURITY : IoT security issues, how to design an IoT system, Hardware, software and network security related to IoT systems - Basics of cryptographic solutions to IoT systems **SECURITY CONCEPTS IN CONTEXT TO IIoT DEVICES:** Confidentiality, privacy, integrity, authentication, non-repudiation, Virtualization **IoT SECURITY THREATS AND COUNTERMEASURES:** System-Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyper jacking.	**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	Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security	CL3
CO2	Explore IoT technologies, architectures, standards, and regulation	CL3
CO3	Realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices	CL3
CO4	Examine security challenges and developments that will likely shape the industrial landscape in the future	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Introduction to IIOT Kits.	CO1	CL3
2.	Measurement of temperature & pressure values of the process using raspberry pi/node mcu.	CO1	CL3
3.	Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using Raspberry pi/node mcu.	CO2	CL3

4.	Demonstration of MQTT communication.	CO2	CL3
5.	Demonstration of LoRa communication.	CO3	CL3
6.	Visualization of diverse sensor data using dashboard (part of IoT's 'control panel')	CO3	CL3
7.	Using an IOT device establishes the connection between two devices.	CO4	CL3
8.	Implementation of Boolean expression using ladder diagram.	CO4	CL3
9.	Simulation of PLC to understand the process control concept.	CO5	CL3
10.	Machine to Machine communication.	CO5	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			1	2		1	3	2	2	2
CO2	3	2	2	2	2			1	2		1	3	2	2	2
CO3	3	2	2	2	2			1	2		1	3	2	2	2
CO4	3	2	2	2	2			1	2		1	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
	Practical Session (Laboratory Component)	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%)			Practical Sessions (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:

- 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:

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 totalling to 20 covering all the four modules.
3. In Part B, Question 2 and 3 will be compulsory from first and second module.
4. 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.
5. 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. 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):

INDUSTRIAL AUTOMATION

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	**BRA702T**	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 familiarize students with the basic elements, functions, and levels of automation, and to introduce key hardware components used in process control.
- To introduce the structure and application of automated production lines and identification systems used in industrial manufacturing.
- To develop knowledge of PLC hardware, programming techniques, and ladder logic construction using timers, counters, and control instructions.
- To enable students to design and apply various operational function blocks in ladder logic and to understand the fundamentals of SCADA 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 automation: Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data.	**10 Hours**

MODULE - II

Automated production lines: Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems, automatic identification methods, barcode technology, radio frequency identification, other AIDC technologies.	**10 Hours**

MODULE - III

PLC Hardware & Programming Types of Programming, construction of PLC ladder diagrams, Controlling Program Flow in a Ladder Logic Program. Various Types of Addressing Used within a PLC, PLC Programming input instructions, Timers and Counters: What are timers & Counters, Use of timers and counters within a ladder logic program, Basic concepts of function blocks.	**10 Hours**

MODULE - IV

Different operational blocks Math block, Logical block, Compare block, Sequential & Shift, Program block, Control block, Ladder design of math, logical and compare functions, Ladder design of sequential & shift functions, Ladders design of program functions, Ladder design of control functions. **Introduction to SCADA** Introduction and SCADA Basics. Importance of SCADA in Industrial Automation, Basic operation of SCADA-Basic window property concepts of SCADA	**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 concepts of automation and process control, including hardware components like sensors, actuators, and converters.	CL3
CO2	Use automated production line principles and identification technologies such as barcodes and RFID to analyze manufacturing operations.	CL3
CO3	Construct PLC ladder logic programs using timers, counters, and control instructions for automation tasks.	CL3
CO4	Implement mathematical, logical, and control function blocks using ladder logic, and demonstrate the basic features of SCADA 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	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:

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

DEEP REINFORCEMENT LEARNING
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BRA703E1**	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 machine learning knowledge, linear algebra, multivariable calculus, Deep Learning.

COURSE OBJECTIVES:

- To provide in-depth theoretical and practical understanding of reinforcement learning, progressing from foundational concepts to advanced deep learning-based techniques. The course aims to equip students with the ability to design, implement, and apply DRL models to complex tasks in robotics and automation.

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 RL: Agent-environment interaction, rewards, returns, exploration vs. exploitation, Elements of RL: Policy, value function, model of the environment. **Markov Decision Processes**: Markov property, state transitions, reward function, discounted returns. **Bellman Equations**: Expectation and optimality equations, fixed-point iteration.	**10 Hours**

MODULE - II

Dynamic Programming: Policy evaluation, improvement, iteration; limitations in large state spaces. **Monte Carlo Methods:** On-policy vs off-policy MC, first-visit and every-visit MC methods. **Temporal-Difference Learning:** TD(0), SARSA, Q-learning; bootstrapping; online and offline learning.	**10 Hours**

MODULE - III

Function Approximation: Motivation, linear vs. nonlinear (NN-based) approximations. **Deep Q-Learning:** DQN, experience replay, target networks, Extensions to DQN-Double DQN, Dueling DQN, Prioritized Experience Replay. **Policy-based Methods:** Introduction to policy gradients, REINFORCE algorithm.	**10 Hours**

MODULE - IV

Advanced DRL Algorithms : Actor-Critic Methods: A2C, A3C, PPO, Exploration Strategies: Entropy regularization, curiosity-driven learning, Implementation Frameworks: TensorFlow, PyTorch, OpenAI Gym, Stable-Baselines3. **Applications in Robotics & Automation:** Applying DRL in Robotics - Sim2Real transfer, motion planning, manipulation tasks, Industrial Use Cases: Automated control, autonomous navigation, robotic assembly.	**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 core RL techniques including MDPs and Bellman equations to solve sequential decision problems.	CL3
CO2	Implement and evaluate classical RL algorithms such as DP, MC, TD, and Q-learning.	CL3
CO3	Design deep RL architectures using DQNs and policy gradient methods.	CL3
CO4	Apply DRL models to real-world robotics and automation scenarios.	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					1		2	1	1	
CO2	3	3	2		1					1		2	1	1	
CO3	3	3	3		2					1		2	1	1	
CO4	3	3	3		2					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

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. Reinforcement Learning: An Introduction, Book by Andrew Barto and Richard S. Sutton, 2nd Edition
2. Algorithms Reinforcements learning by Csaba Szepesvari,2011.
3. Foundations of Deep Reinforcement Learning: Theory and Practice in Python (Addison-Wesley Data & Analytics Series) 1st Edition
4. Deep Reinforcement Learning with Python, Sudharsan Ravichandiran, Packt, Second Edition.
5. Reinforcement Learning: Industrial Applications of Intelligent Agents ,Phil Winder ,Oreilly,1st Edition
6. Deep Reinforcement Learning Hands-On (2nd Edition)- Maxim Lapan,Packt Publishers
7. Reinforcement Learning for Robotics-Edited by D. H. Kim and S. K. Behera (Springer, Lecture Notes Series)

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

1. Google DeepMind/UCL RL notes: https://www.davidsilver.uk/teaching/
2. CS 285 at UC Berkeley,Deep Reinforcement Learning notes/videos: https://rail.eecs.berkeley.edu/deeprlcourse/

BIG DATA ANALYTICS
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	BRA703E2	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:

- Understand fundamentals of Big Data analytics
- Explore the Hadoop framework and Hadoop Distributed File system
- Illustrate the concepts of NoSQL using MongoDB and Cassandra for Big Data
- Employ MapReduce programming model to process the big data
- Understand various machine learning algorithms for Big Data Analytics, Web Mining and Social Network Analysis.

COURSE OBJECTIVES:

- To introduce the fundamentals of Big Data architecture, data sources, preprocessing, and analytics applications.
- To provide hands-on knowledge of Hadoop ecosystem, HDFS, and essential Hadoop tools for managing large-scale data.
- To explore NoSQL databases like MongoDB and Cassandra and implement data processing using MapReduce, Hive, and Pig.
- To apply machine learning and data mining techniques for analyzing text, web, and social network data in Big Data environments.

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 Big Data Analytics: Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data Storage and Analysis, Big Data Analytics Applications and Case Studies.	**10 Hours**

MODULE - II

Introduction to Hadoop (T1): Introduction, Hadoop and its Ecosystem, Hadoop Distributed File System, MapReduce Framework and Programming Model, Hadoop Yarn, Hadoop Ecosystem Tools. Hadoop Distributed File System Basics (T2): HDFS Design Features, Components, HDFS User Commands. **Essential Hadoop Tools (T2):** Using Apache Pig, Hive, Sqoop, Flume, Oozie, HBase.	**10 Hours**

MODULE - III

NoSQL Big Data Management, MongoDB and Cassandra: Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks, MongoDB, Databases, Cassandra Databases. **MapReduce, Hive and Pig:** Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.	**10 Hours**

MODULE - IV	
Machine Learning Algorithms for Big Data Analytics: Introduction, Estimating the relationships, Outliers, Variances, Probability Distributions, and Correlations, Regression analysis, Finding Similar Items, Similarity of Sets and Collaborative Filtering, Frequent Itemsets and Association Rule Mining. Text, Web Content, Link, and Social Network Analytics: Introduction, Text mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and analyzing a Web Graph, Social Network as Graphs and Social Network Analytics.	**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 Big Data architecture and apply preprocessing and storage techniques to manage data quality and scalability.	CL3
CO2	Utilize Hadoop ecosystem components including HDFS, MapReduce, Pig, Hive, Sqoop, and HBase for distributed data processing.	CL3
CO3	Implement Big Data solutions using NoSQL databases such as MongoDB and Cassandra, and perform computations using MapReduce, Hive, and Pig.	CL3
CO4	Apply machine learning and analytics techniques for mining large-scale structured and unstructured data from web, social networks, and text sources.	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	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:

1. Tom White, “Hadoop: The Definitive Guide”, 4th Edition, O‟Reilly Media, 2015.ISBN-13: 978-9352130672
2. Boris Lubinsky, Kevin T Smith, Alexey Yakubovich, "Professional Hadoop Solutions", 1stEdition, Wrox Press, 2014ISBN-13: 978-8126551071,
3. Raj Kamal and Preeti Saxena, “Big Data Analytics Introduction to Hadoop, Spark, and Machine-Learning”, McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966

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

1. https://www.youtube.com/watch?v=bAyrObl7TYEhttps://www.youtube.com/watch?v=LZ82iANWBL0&t=28s
2. https://www.youtube.com/watch?v=bY6ZzQmtOzk

AGENTIC AI
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BRA703E3**	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 proficiency in Python programming (understanding of variables, loops and functions).
- Familiarity with foundational concepts in artificial intelligence, machine learning, or robotics.

COURSE OBJECTIVES:

- Understand and explain the fundamental concepts of generative AI and agentic systems in the context of robotics.
- Analyze and design intelligent agent architectures with capabilities for reasoning, learning, and decision-making.
- Implement reflection and introspection mechanisms in AI agents for improved performance and adaptability.
- Design and evaluate multi-agent systems using coordinator-worker-delegator approaches.
- Assess trust, safety, and ethical considerations in agentic AI systems for robotics applications.
- Apply agentic AI principles to solve real-world problems in industrial robotics and automation.
- Demonstrate proficiency in planning algorithms and tool use integration for robotic agents.
- Evaluate the effectiveness of agentic AI systems in various robotics scenarios.

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

Fundamentals of Generative AI - Introduction to generative AI and its role in modern AI systems, Types of generative AI models: VAEs, GANs, Autoregressive models and Transformer architecture, LLM-powered AI agents and their capabilities, Applications of generative AI across domains, Challenges and limitations of generative AI systems. **Principles of Agentic Systems**-Understanding self-governance, agency, and autonomy in AI systems, reviewing intelligent agents and their fundamental characteristics, Exploring the architecture of agentic systems and design patterns, Understanding multi-agent systems and their coordination mechanisms. **Essential Components of Intelligent Agents**-Knowledge representation in intelligent agents, Reasoning mechanisms in intelligent agents, learning mechanisms for adaptive agents, Decision-making and planning in agentic systems, Enhancing agent capabilities with generative AI integration.	**10 Hours**

MODULE - II

Reflection and Introspection in Agents - The importance of reflection in autonomous agent behavior, Introspection mechanisms in intelligent agents, implementing reflective capabilities in practice, Use cases and real-world examples of reflective agents **Tool Use and Planning in Agents**-Understanding the concept of tool use in autonomous agents, Planning algorithms for agents and their implementation, integrating tool use and planning capabilities, Exploring practical implementations and frameworks. **Effective Agentic System Design Techniques**-Focused system prompts and instructions for agents, State spaces and environment modeling for agent operation, Agent memory architecture and context management systems, Sequential and parallel processing in agentic workflows.	**10 Hours**

MODULE - III	
Coordinator, Worker, and Delegator (CWD) Approach-Understanding the CWD model and its applications, designing agents with specific role assignments, Communication protocols and collaboration between agents, Implementing the CWD approach in generative AI systems, **Trust, Safety, and Ethical Considerations** - Building trust in generative AI systems and agent reliability, Techniques for establishing trust through transparency, implementing explainability in agentic systems, Handling uncertainty and biases in agent decision-making, understanding potential risks and safety challenges, ensuring safe and responsible AI development, exploring ethical guidelines and frameworks for agentic AI, Addressing privacy and security concerns in multi-agent systems.	**10 Hours**
MODULE - IV	
Agentic AI in Industrial Robotics-Overview of Agentic AI applications in robotics systems, Perception and interaction with the physical environment, Navigation, exploration, and autonomous task completion, multi-agent coordination in robotic systems, Human-robot collaboration, and interaction paradigms. **Agentic AI in Industrial Automation-**Autonomous industrial agents and their deployment, Intelligent manufacturing and process optimization, Adaptive quality control and inspection systems, Future trends and opportunities in Industry 5.0, Case studies and real-world implementations.	**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 foundational principles of generative AI and agentic systems to design intelligent agents with enhanced capabilities for autonomous decision-making and multi-agent coordination.	CL3
CO2	Implement advanced agent capabilities including reflection, introspection, and tool integration to develop sophisticated agentic systems with memory management and workflow processing.	CL3
CO3	Construct multi-agent collaborative systems using coordinator-worker-delegator models while implementing trust mechanisms and addressing ethical considerations in generative AI applications.	CL2
CO4	Deploy agentic AI solutions in robotics and industrial automation contexts by integrating perception systems, navigation algorithms, and human-robot collaboration frameworks.	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. "Building Agentic AI Systems: Master the art of building AI agents with large language models using the coordinator, worker, and delegator approach" by Biswas, A., Talukdar, W., & Scott, M.R. (2025). Packt Publishing.
2. "Multiagent Robotic Systems" by Liu, J. & Wu, J. (Latest Edition). CRC Press.
3. "Agentic AI: A Comprehensive Guide" by Davenport, T. et al. (2025). Harvard Business Review Press.
4. "AI Agents 101: Complete Guide for Understanding, Integrating, and Succeeding with Agentic AI" by Harbinger Group (2025).
5. "Generative Artificial Intelligence in Robotic Manipulation: A Survey" by Zhang, K. et al. (2025). Available on arXiv.
6. "The Future of Agentic AI in Industrial Applications" by Smith, J. & Johnson, M. (2025). MIT Press.
7. "Trust and Explainability in AI Systems" by Atf, Z. & Lewis, P.R. (2025). Available on arXiv.

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

1. Hugging Face Agents Course: https://huggingface.co/learn/agents-course/
2. AI Agent Developer Specialization: https://www.coursera.org/specializations/ai-agents
3. OpenAI Documentation on Agentic Systems- https://cdn.openai.com/business-guides-and-resources/a-practical-guide-to-building-agents.pdf

MEDICAL ROBOTICS

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	BRA703E4	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 Basics of Robotics, Human Anatomy, Control Systems

COURSE OBJECTIVES:

- To introduce the fundamental principles and technologies used in medical robotics.
- To understand the design and control of robotic systems used in surgical, diagnostic, and rehabilitation applications.
- To explore the integration of robotics with medical imaging and AI for enhanced precision and automation.
- To analyze ethical, legal, and safety issues related to the deployment of robots in healthcare environments.

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 Medical Robotics: Overview of medical robotics and its applications, History and evolution of robots in healthcare, Classification: Surgical robots, rehabilitation robots, diagnostic robots, Basic anatomy for robotic applications, Key requirements in medical robot design (biocompatibility, precision, safety)	**10 Hours**

MODULE - II

Design and Actuation Mechanisms: Design criteria for medical robots, Kinematics and dynamics of medical manipulators, Actuators and sensors used in medical robots (piezoelectric, pneumatic, micro actuators), Miniaturization in surgical tools, Haptics and teleoperation systems.	**10 Hours**

MODULE - III

Control Systems and Medical Imaging Integration: Control strategies in surgical robots: position, force, and impedance control, Robot-assisted imaging: MRI, CT, Ultrasound-guided robotics, Navigation and registration techniques, Integration with real-time imaging and feedback systems, Role of AI and ML in robotic surgery and diagnostics.	**10 Hours**

MODULE - IV

Applications, Safety, and Ethical Aspects: Case studies: da Vinci Surgical System, Cyber Knife, rehabilitation exoskeletons, Robotics in prosthetics and assistive technologies, Standards and regulatory frameworks (FDA, ISO), Ethical issues: patient safety, autonomy, data privacy, Future trends and innovations in medical robotics	**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 concepts, types, and clinical applications of medical robotics.	CL3
CO2	Apply principles of kinematics, actuation, and sensing in the design of medical robotic systems.	CL3
CO3	Demonstrate the ability to integrate control systems and medical imaging for precise robotic interventions.	CL3
CO4	Evaluate real-world applications of medical robotics and address associated ethical and safety considerations.	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	1		2			
CO2	2	2	1						1	1		2			
CO3	2	2	1						1	1		2			
CO4	2	2	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
	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. "Medical Robotics" by Paula Gomes – Wiley, 2011
2. "Surgical Robotics: Systems Applications and Visions" by Jacob Rosen, Blake Hannaford, Richard Satava – Springer, 2011
3. "Introduction to Robotics in Surgery" by Farid Gharagozloo and Keith W. Hentel – Springer, 2021
4. "Robot-Assisted Surgery: Fundamentals and Applications" by M. C. Carrozza and E. Guglielmelli – CRC Press, 2020

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

INTRODUCTION TO ROBOT PROGRAMMING

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	**BRA704Q1**	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 basic programming languages.

COURSE OBJECTIVES:

- Impart knowledge on basics of Robot programming.
- Understand the VAL language applications.
- Understand the RAPID and AML language applications.
- Fundamentals virtual robot software.

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: Types of programming, Flex Pendant, Lead through programming, Coordinate systems of Robot, Robot controller, major components, functions, Wrist Mechanism, Interpolation, Interlock commands, Operating mode of robot, Jogging types, Robot specifications, Motion commands, end effectors and sensors commands.

VAL Language: Robot Languages, Classifications, Structures, VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program, WAIT, SIGNAL and DELAY command for communications using simple applications.

VAL-II: Programming, basic commands, applications - simple problem using conditional statements, simple pick and place applications, production rate calculations using robot.

10 Hours

MODULE – II

RAPID Language: RAPID language basic commands, Motion Instructions, Pick and place operation using Industrial robot, manual mode, automatic mode, subroutine command-based programming, move master command language - introduction, syntax, simple problems.

10 Hours

MODULE – III

AML Language: General description, elements and functions, statements, constants and variables, program control statements, operating systems, motion, sensor commands, data processing.

10 Hours

MODULE - IV

Practical Study of Virtual Robot: Robot cycle time analysis, Multiple robot and machine interference, Process chart, Simple problems, Virtual robotics.

Robot studio online software: Introduction, Jogging, components, work planning, program modules, input and output signals, singularities, collision detection, repeatability measurement of robot, robot economics.

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 robot programming and outline the key features of VAL I and VAL II programming languages.	CL3
CO2	Describe the essential programming constructs and structure of the RAPID language used in industrial robots.	CL3
CO3	Illustrate the core programming principles and syntax of the AML (A Manufacturing Language) system.	CL3
CO4	Summarize the practical applications and benefits of using virtual robots in simulation environments.	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		3	
CO2	3	3	2					2		2		3		3	
CO3	3	3	2					2		2		3		3	
CO4	3	3	2					2		2		3		3	
CO5	3	3	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
		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. S. R. Deb, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, 1994.
2. Mikell. P. Groover, "Industrial Robotics Technology", Programming and Applications, McGraw Hill Co, 1995.
3. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987.
4. Craig. J. J. "Introduction to Robotics mechanics and control", Addison-Wesley, 1999.

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

1. https://www.mathworks.com/discovery/robotprogramming.

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AI APPLICATIONS IN ROBOTICS AND AUTOMATION

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	**BRA704Q2**	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:

- A course on Artificial intelligence and Machine Learning

COURSE OBJECTIVES:

- Understand the fundamental concepts of AI and their application in robotics and automation systems.
- Analyse perception, learning, and decision-making processes in intelligent robotic systems.
- Apply machine learning and deep learning algorithms to robotic control and automation tasks.
- Develop and simulate AI-driven robotic systems for real-world applications.
- Evaluate ethical and safety issues in deploying AI in automation and robotics.

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 AI and Robotics Overview of AI and Robotics: Definitions, Scope, and Interdisciplinary Nature, Evolution of Intelligent Systems in Automation, Types of Robots: Industrial, Service, Mobile, and Collaborative Robots, Sensors and Actuators in Robotics, Introduction to Intelligent Automation Systems	**10 Hours**

MODULE - II

AI Techniques in Robotic Perception and Motion Path Planning Algorithms: A*, D*, RRT, Probabilistic Roadmaps, Visual Perception: Object Detection, Recognition using CNNs, Sensor Fusion: Kalman Filters, Bayesian Networks**,** Environment Mapping: SLAM (Simultaneous Localization and Mapping)**,** Motion Planning and Control using AI Techniques	**10 Hours**

MODULE - III

Machine Learning & Deep Learning in Robotics Supervised, Unsupervised, and Reinforcement Learning, Neural Networks, CNNs, and RNNs for Robotic Applications, Deep Q-Learning and Policy Gradient Methods, Transfer Learning in Robotic Systems, Case Studies: AI in Humanoid and Autonomous Robots	**10 Hours**

MODULE - IV

AI in Industrial Automation and Ethics Intelligent Automation in Manufacturing and Smart Factories**,** Human-Robot Interaction (HRI) and Collaborative Robotics (Cobots), AI for Predictive Maintenance and Quality Control Ethics, Safety, and Explainability in AI-driven Robotics**,**Case Studies: Autonomous Vehicles, Warehouse Robotics, Medical Robotics	**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	To explain the foundational concepts of AI and its integration with robotic systems, including sensor and actuator technologies, robot classification, and the basics of intelligent automation.	CL2
CO2	To apply AI algorithms for robotic perception, sensor fusion, and motion planning, utilizing techniques such as SLAM, path planning, and visual object recognition.	CL4
CO3	To develop and implement machine learning and deep learning models for robotic applications such as autonomous decision-making, environment adaptation, and control strategies.	CL4
CO4	To analyze the use of AI in industrial automation and collaborative robotics, and evaluate ethical, safety, and societal considerations involved in deploying AI-powered automation systems.	CL4

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	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:

"Artificial Intelligence for Robotics" by Francis X. Govers – CRC Press

"Probabilistic Robotics" by Sebastian Thrun, Wolfram Burgard, and Dieter Fox – MIT Press

"Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms" by Nikolaus Correll et al. – CreateSpace

"Robotics: Modelling, Planning and Control" by Bruno Siciliano and Lorenzo Sciavicco – Springer

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

INTRODUCTION TO PLC & SCADA

(Effective from the Academic Year 2024 - 2025)

VII SEMESTER

Course Code	BRA704Q3	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 electrical circuits and industrial automation concepts, familiarity with programming languages or logic diagrams.

COURSE OBJECTIVES:

- Understand basic PLC terminologies, principles, PLC architecture and operation.
- Familiarize different programming languages of PLC.
- Develop PLC logic for simple applications using ladder logic.
- Understand the hardware and software behind PLC and SCADA.
- Exposures about communication architecture of PLC/SCADA.

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

Fundamentals of PLC and Automation: Introduction to Automation: Need, scope, and tools, Evolution and Architecture of PLC, PLC Block Diagram and its Working, Selection Criteria and Types of PLCs, Advantages, Limitations, and Applications, Networking of PLCs.	**10 Hours**

MODULE - II

PLC Hardware and Programming Basics: PLC Hardware: Input/Output Modules – working principles, specifications, and wiring, Interfacing Instruction Set, Basics of Ladder Programming, Ladder Logic Development for Standard Applications (e.g., motor, lamp).	**10 Hours**

MODULE - III

Advanced PLC Programming and Applications: Programming Languages for PLCs (IEC 61131 standard), Relay-based Instructions: Timer, Counter, Arithmetic and Data Handling Instructions, Application Case Studies: Motor Control, Traffic Light Control.	**10 Hours**

MODULE - IV

SCADA Systems and Integration with PLC: Introduction to SCADA: Architecture, Elements, Block Diagram, Types of SCADA, MTU, RTU Functions, and Communication Protocols, SCADA-PLC Interfacing Techniques, SCADA Applications: ON-OFF Lamp, Traffic Light, Water Level, Motor Control, Creating SCADA Displays for Real-time Monitoring.	**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 fundamentals, architecture, and types of PLCs used in industrial automation systems.	CL2
CO2	Demonstrate the ability to configure PLC hardware, develop basic ladder logic programs, and interface input/output devices.	CL3
CO3	Apply advanced PLC programming techniques using IEC 61131 standard to implement real-time automation applications.	CL3
CO4	Analyze the architecture and communication protocols of SCADA systems and develop SCADA-based control and monitoring solutions integrated with PLCs.	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			
CO2	3	2	3	1	3				1		1	2			
CO3	3	2	3	1	3				1		2	2			
CO4	3	3	2	2	3	1	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**
	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. Madhuchannd Mitra and Samerjit Sengupta, Programmable Logic Controllers Industrial Automation- an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles and Applications, Pearson publication
3. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition.
4. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

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

1. https://nielit.gov.in/calicut/calicut/content/online-course-industrial-automation-plc-scada
2. https://onlinecourses.nptel.ac.in/noc21_me67/preview

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INTRODUCTION TO SOFT ROBOTICS
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code	**BRA704Q4**	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 sensors and actuators.

COURSE OBJECTIVES:

- To understand potential and limitation of soft robotic technologies.
- Understand how to model, design, and characterize materials for soft robotics.
- Learn how to design and manufacture a soft robot.
- Learn how to use soft robotic technologies to address unsolved challenges in robotics.

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 soft robotics: Definitions and Applications. Morphological computation and Bio inspired design. **Materials for soft robotics**: Elastomers, Thermoplastics and textiles, Advanced materials	**10 Hours**
MODULE - II	
Soft Actuation: Cable driven soft robots, Fluidic actuation, Dielectric elastomers, Shape memory alloys, Additional actuation strategies.	**10 Hours**
MODULE - III	
Variable Stiffness mechanisms: Introduction to variable stiffness structures Jamming mechanisms **Design and control of soft robots:** Typical soft robot architectures On-board powering, On-board control	**10 Hours**
MODULE - IV	
Structural Difference between Hard and Soft Robots, Bio-inspiration in Soft Robotics, Hydrostatic Skeletons, Muscular Hydrostats, Soft Active Plant Structure, Soft Robots, Actuators, Pneumatic Artificial Muscles, Electroactive Polymers. **Soft electronics and soft sensing:** How to embed sensing capabilities and conductive elements in soft structures Soft resistive, capacitive, and inductive sensing.	**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 basic concept and potential of soft robotics and materials for soft robotics.	CL2

CO2	The basics of mechanisms, electronics, materials, information processing, related to soft robotics.	CL2
CO3	Possess the knowledge and skills to design and control soft robots with various architectures, implement variable stiffness mechanisms, and understand the role of jamming mechanisms in adaptable structure.	CL3
CO4	Understand the structural differences between hard and soft robots, the principles of bio-inspiration i n soft robotics, and various actuation methods and embedding sensing capabilities.	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	
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. Soft Robotics: Trends, Applications and Challenges: Proceedings of the Soft Robotics Week, April 25-30, 2016, Livorno, Italy (Biosystems & Biorobotics Book 17) 1st ed. 2017 Edition, Kindle Edition
2. Soft Robotics Editor: Gareth J. Monkman Year of Publication: 2022
3. Soft Robotics by Matthew Borgatti

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

1. https://www.youtube.com/c/softroboticsinc

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COMPUTER VISION AND DEEP LEARNING LAB
(Effective from the Academic Year 2024 - 2025)
VII SEMESTER

Course Code		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:

- Proficiency in Python programming and use of Jupyter/Colab environments.
- Basic understanding of Computer Vision concepts (image filtering, edge detection, feature extraction).
- Introductory knowledge of Deep Learning frameworks (PyTorch and TensorFlow).
- Familiarity with convolutional neural networks and their applications in image classification.
- Basic skills in data visualization using libraries like Matplotlib and Seaborn.
- Completion of prior theory courses in Artificial Intelligence and Machine Learning, and Computer Vision and Deep Learning.

COURSE OBJECTIVES:

- Provide hands-on experience in implementing computer vision techniques using OpenCV and Python.
- Introduce practical deep learning workflows using PyTorch and TensorFlow on real-world image datasets.
- Strengthen students' ability to build, train, and evaluate CNN models on small-scale datasets.
- Enable students to apply data augmentation, feature detection, and transfer learning in vision-based tasks.
- Develop proficiency in visualizing results and interpreting model performance using standard tools.
- Bridge the gap between theory and application by executing efficient vision and DL programs.

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	**Basic Image Processing with OpenCV:** Load and process images by converting to grayscale, applying Gaussian blur, and thresholding to create binary images using OpenCV.
2	**Edge Detection using Canny Algorithm:** Perform edge detection on sample images using OpenCV's Canny edge detector and visualize results with Matplotlib.
3	**Feature Detection with ORB:** Detect and visualize key points in images using the ORB (Oriented FAST and Rotated BRIEF) algorithm in OpenCV.
4	**Face Detection using Haar Cascades:** Apply pre-trained Haar Cascade classifiers to detect faces in images and draw bounding boxes around detected regions.
5	**Image Contrast Enhancement:** Use histogram equalization to improve image contrast and visualize the histogram before and after enhancement.
6	**Data Augmentation using Keras:** Generate augmented image datasets using Keras's ImageDataGenerator with transformations such as rotation, flipping, and shifting.

7	**Digit Classification with CNN (TensorFlow/Keras):** Build and train a simple convolutional neural network to classify handwritten digits from the MNIST dataset.
8	**Image Classification with CNN (PyTorch):** Train a convolutional neural network on the CIFAR-10 dataset using PyTorch and evaluate its performance.
9	**Model Performance Visualization:** Visualize model training history (accuracy/loss) and plot confusion matrices using Matplotlib and Seaborn for better interpretation.
10	**Transfer Learning with Pretrained CNNs:** Use a pre-trained MobileNetV2 model to classify real-world images and interpret predictions using top-3 decoded labels.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply computer vision techniques such as filtering, edge detection, and feature extraction using OpenCV on real-world images.	CL 3
CO2	Implement and train deep learning models using PyTorch and TensorFlow for basic image classification tasks.	CL 3
CO3	Analyze the effects of data augmentation and preprocessing techniques on the performance of deep learning models.	CL 3
CO4	Evaluate model performance using metrics such as accuracy, confusion matrix, and loss curves for various image datasets.	CL 3
CO5	Design and execute small-scale vision-based solutions using classical CV and CNN-based methods for real-time robotic perception tasks.	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			2							1		2	
CO2	3	3	3		2							1		2	
CO3		3		3	2							1		2	
CO4	3	3		3								1		2	
CO5	3	3	3	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. Learning OpenCV 4: Computer Vision with Python, Adrian Kaehler & Gary Bradski, O'Reilly Media, 2nd Edition (2019).
2. Deep Learning with PyTorch, Eli Stevens, Luca Antiga, Thomas Viehmann, Manning Publications, 1st Edition (2020).
3. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, O'Reilly Media, 2nd Edition (2019).

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

- OpenCV-Python Tutorials (Official Documentation) - https://docs.opencv.org/4.x/d6/d00/tutorial_py_root.html
- Deep Learning with PyTorch: A 60 Minute Blitz (Official PyTorch Tutorial) - https://pytorch.org/tutorials/beginner/deep_learning_60min_blitz.html
- TensorFlow in Practice Specialization by Andrew Ng (Coursera - Free Audit Option): https://www.coursera.org/specializations/tensorflow-in-practice