SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

DEPARTMENT OF MECHANICAL ENGINEERING

Program – Robotics & Automation

2022

Scheme & Syllabus

Effective from the Academic Year 2022 - 2023

SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. IN ROBOTICS AND AUTOMATION

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2023 - 24)

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	BSC	MA322T1R	Linear Algebra and Numerical Techniques	BSC	BSC	03	00	00	00	3	50	50	100	3
2	IPCC	CS322I2R	Data Structures	CS	CS	03	00	02	00	3	50	50	100	4
3	IPCC	ME322I3R	Material Science and Manufacturing	ME	ME	03	00	02	00	3	50	50	100	4
4	PCC	ME322T4R	Mechanics of Materials	ME	ME	03	00	00	00	3	50	50	100	3
5	PCCL	ME322L5R	Machine Drawing and GD&T	ME	ME	00	00	03	00	3	50	50	100	1
6	ESC/ETC/PLC	RA322T6R (A)	Introduction to Robotics	RA	RA	03	00	00	00	3	50	50	100	3
7	UHV	HU32287X	UHV Course	BSC	BSC	01	00	00	00	1	50	50	100	1
8	AEC / SEC	RA32298RX	Ability Enhancement Course III / Skill Enhancement Course III	RA	RA	01	00	00	00	1	50	50	100	1
9	MC	N322N10X	National Service Scheme (NSS)	NSS / PED / Yoga		00	00	02	00	Registrations to any one of the courses be completed (as per the choice of the student) and activities to be carried out.				0
		P322N10X	Physical Education (PE) (Sports and Athletics)											
		Y322N10X	Yoga											
											400	**400**	**800**	**20**

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ESC/ETC/PLC			
RA322T6R (A)	Introduction to Robotics		

ABILITY ENHANCEMENT COURSE III / SKILL ENHANCEMENT COURSE III			
RA32298RA	Python for Scientific Computing	RA32298RB	Generative design lab
RA32298RC	Embedded systems Lab	RA32298RD	Game Design lab

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

1			Additional Mathematics I	BSC	BSC	02	00	00	01	3	50	50	100	0

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

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

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

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga: 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 (for Four 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 to the lateral entry Diploma holders admitted to the second year of the B.E., programs. 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). These courses are slated for both CIA and SEE.
2) Additional Mathematics I 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.
3) Successful completion of the courses Additional Mathematics I 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.
4) In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIA marks and 40% of the prescribed SEE 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.

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

1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
3) In case, any student fails to register for NSS, PE or Yoga/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.
4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
5) 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.

BoS SPECIFIED NPTEL COURSES
(APPLICABLE ONLY TO THE STUDENTS WHO FAIL IN A COURSE MORE THAN FOUR TIMES)

Course Code	Course Name	Alternative NPTEL Courses*
A	Introduction to Robotics	Introduction to Robotics, By Prof. Asokan T, Prof. Balaraman Ravindran, Prof. Krishna Vasudevan | IIT Madras

***subjected to change depending on the courses offered by the NPTEL.**

Note:

- The student has to provide the evidences for registering to the course, assignment submission, attending the examination and the certificate provided by NPTEL indicating the clearance of the Course by the candidate.
- Only on submitting the valid documents, the student will be awarded with the credits mentioned against the course(s)

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OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2023 - 24)

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	EC422I1R	Analog and Digital Electronics Circuits	EC	EC	03	00	02	00	3	50	50	100	4
2	IPCC	RA422I2R	Instrumentation and Control Systems	RA	RA	03	00	02	00	3	50	50	100	4
3	PCC	ME422T3R	Theory of Machines	ME	ME	03	00	00	00	3	50	50	100	3
4	PCC	CS422T4R	Object Oriented Programming using C++	CS	CS	03	00	00	00	3	50	50	100	3
5	PCCL	ME422L5R	CNC and 3D Printing Laboratory	ME	ME	00	00	03	00	3	50	50	100	1
6	ESC/ETC/PLC	MA422T6R	Statistical Methods and Probability Theory	BSC	BSC	03	00	00	00	3	50	50	100	3
7	AEC / SEC	RA42297RA	Data Wrangling, Analysis and Visualization	RA	RA	01	00	00	00	1	50	50	100	1
8	BSC	BS422T8X	Biology for Engineers	BSC	BSC	02	00	00	00	2	50	50	100	2
9	UHV	HU42289X	Understanding Harmony And Ethical Human Conduct	BSC	BSC	01	00	00	00	1	50	50	100	1
10	MC	N422N10X	National Service Scheme (NSS)	NSS / PED / Yoga		00	00	02	00	Activities to be carried out by the student in the registered course				0
		P422N10X	Physical Education (PE) (Sports and Athletics)											
		Y422N10X	Yoga											
											450	**450**	**900**	**22**

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ESC/ETC/PLC			
MA422T6R	Statistical Methods and Probability Theory		

ABILITY ENHANCEMENT COURSE IV / SKILL ENHANCEMENT COURSE IV			
RA42297RA	Data Wrangling, Analysis and Visualization	RA42297RB	Prototype fabrication lab
RA42297RC	Sensors and actuators lab	RA42297RD	Animation Lab

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

1			Additional Mathematics II	BSC	BSC	02	00	00	01	3	50	50	100	0

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

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

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

National Service Scheme (NSS)/ Physical Education (PE)/ Yoga: 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 (for Four 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 to the lateral entry Diploma holders admitted to the second year of the B.E., programs. 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). These courses are slated for both CIA and SEE.
2) Additional Mathematics I 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.
3) Successful completion of the courses Additional Mathematics I 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.
4) In case, any student fails to register for the said course/fails to secure the minimum 40% of the prescribed CIA marks and 40% of the prescribed SEE 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.

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

1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
3) In case, any student fails to register for NSS, PE or Yoga/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.
4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
5) 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.

BoS SPECIFIED NPTEL COURSES
(APPLICABLE ONLY TO THE STUDENTS WHO FAIL IN A COURSE MORE THAN FOUR TIMES)

Course Code	Course Name	Alternative NPTEL Courses*
A	Statistical Methods and Probability Theory	Introduction to Probability Theory and Statistics, By Prof. S Dharmaraja | IIT Delhi

***subjected to change depending on the courses offered by the NPTEL.**

Note:

- The student has to provide the evidences for registering to the course, assignment submission, attending the examination and the certificate provided by NPTEL indicating the clearance of the Course by the candidate.
- Only on submitting the valid documents, the student will be awarded with the credits mentioned against the course(s)

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B.E. IN ROBOTICS AND AUTOMATION

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 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	ME522I1R	Hydraulic and Pneumatic Systems	ME	ME	03	00	02	00	3	50	50	100	4
2	IPCC	RA522I2R	Robot Operating System	RA	RA	03	00	02	00	3	50	50	100	4
3	PCC	RA522T3R	Robot Kinematics and Dynamics	RA	RA	03	00	00	00	3	50	50	100	3
4	PCC	CS522T4R	Design and Analysis of Algorithms	CS	CS	03	00	00	00	3	50	50	100	3
5	PCCL	RA522L5R	Virtual Instrumentation Laboratory	RA	RA	00	00	03	00	3	50	50	100	1
6	PEC	CS52216RX	Professional Elective I	CS	CS	03	00	00	00	3	50	50	100	3
7	PROJ	RA522L7R	Mini-Project Work	ME	ME	00	00	04	00	4	50	---	50	2
8	**AEC**	RA52298R	Research Methodology and IPR	ME	ME	01	00	00	00	1	50	50	100	1
9	MC	BS522D9X	Environmental Studies	BSC	BSC	01	00	00	00	1	50	50	100	1
10	MC	N522N9X	National Service Scheme (NSS)	NSS / PED / Yoga		00	00	02	00	Activities to be carried out by the student in the registered course				0
		P522N9X	Physical Education (PE) (Sports and Athletics)											
		Y522N9X	Yoga											
											450	**400**	**850**	**22**

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PROFESSIONAL ELECTIVE COURSES			
CS52216RA	Artificial Intelligence and Machine Learning Fundamentals	CS52216RB	Model-Based Systems Engineering
CS52216RC	Embedded Systems Programming	CS52216RD	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: 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 (for Four 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):

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

1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
3) In case, any student fails to register for NSS, PE or Yoga/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.
4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
5) 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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OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 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	RA622T1R	Technology Entrepreneurship and Business Economics	RA	RA	03	00	00	00	3	50	50	100	3
2	IPCC	RA622I2R	Microcontroller and PLC	RA	RA	03	00	02	00	3	50	50	100	4
3	PCC	RA622T3R	Robot Design and Programing	RA	RA	03	00	00	00	3	50	50	100	3
4	PEC	RA62214RX	Professional Elective Course II	RA	RA	03	00	00	00	3	50	50	100	3
5	OEC	RA62225RX	Open Elective Course-I	RA	RA	03	00	00	00	3	50	50	100	3
6	PROJ	RA622P6R	Project Work Phase I	RA	RA	00	00	08	00	3	100	---	100	4
7	PCCL	RA622L7R	Robotics Programing Laboratory	RA	RA	00	00	03	00	3	50	50	100	1
8	AEC / SEC	RA62298RX	Ability Enhancement Course VI / Skill Enhancement Course VI	RA	RA	01	00	00	00	1	50	50	100	1
9	MC	N622N9X	National Service Scheme (NSS)	Completed during the intervening period of III and VI Semester							50	---	50	0
		P622N9X	Physical Education (PE) (Sports and Athletics)											
		Y622N9X	Yoga											
														22

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ABILITY ENHANCEMENT COURSE V/ SKILL ENHANCEMENT COURSE V			
RA62298RA	ML Using Scikit, Pytorch and Tensorflow	RA62298RB	PLM lab
RA62298RC	SoC lab	RA62298RD	VR app development
PROFESSIONAL ELECTIVE COURSE II			
RA62214RA	Convolutional Neural Networks	RA62214RB	Cyber Physical Systems
RA62214RC	Cloud and Fog Computing	RA62214RD	Cognitive Computing for Robotics and Automation
OPEN ELECTIVE COURSE I			
RA62225RA	Introduction to Robotics	RA62225RB	Introduction to Automation
RA62225RC	Introduction to CPS	RA62225RD	Introduction to robot operating systems

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

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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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 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

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Non-Credit Mandatory Courses (NCMC):

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

1) Securing 40% or more in CIA, 40% or more marks in SEE and 40% or more in the sum total of CIA + SEE leads to successful completion of the registered course.
2) In case, students fail to secure 40 % marks in SEE, they have to appear for SEE during the subsequent examinations and obtain the minimum requirement.
3) In case, any student fails to register for NSS, PE or Yoga/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.
4) Successful completion of the course shall be indicated with a PP Grade in the grade card.
5) 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.

Project Work Phase I: 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 Board of Studies in line with the requirements of VTU and approved by the Academic Council of SCEM.

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OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2025 - 26)

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	RA722I1R	Industrial Internet of Things	CS	CS	03	00	02	00	3	50	50	100	4
2	PCC	RA722T2R	Industrial Automation	RA	RA	03	00	00	00	3	50	50	100	3
3	PEC	RA72213RX	Professional Elective Course III	CS	CS	03	00	00	00	3	50	50	100	3
4	OEC	RA72224RX	Open Elective Course II	RA	RA	03	00	00	00	3	50	50	100	3
5	PCCL	RA722L5R	Applied Artificial Intelligence Lab	CS	CS	00	00	03	00	3	50	50	100	1
6	PROJ	RA722P6R	Project Work Phase II	RA	RA	00	00	16	00	03	100	100	200	8
														22

PROFESSIONAL ELECTIVE COURSE III

RA72213RA	Reinforcement learning for Robotics & Automation	RA72213RB	Principles of Industry 5.0
RA72213RC	Big Data Analytics	RA72213RD	Medical Robotics

OPEN ELECTIVE COURSE II

RA72224RA	Introduction to Robot Programming	RA72224RB	Introduction to PLC and SCADA
RA72224RC	AI applications in Robotics and Automation	RA72224RD	Computer vision

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Note: PCC: Professional Core Course, **PEC**–Professional Elective Course. **OEC:** Open Elective 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 department.

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 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

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 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Work:

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, judgement 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 CIA and SEE evaluation procedure for the Project work will be as provided by the Board of Studies in line with VTU Regulations and approved by the Academic Council of SCEM.

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SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

B.E. IN ROBOTICS AND AUTOMATION

SCHEME OF TEACHING AND EVALUATION 2022
OUTCOME BASED EDUCATION (OBE) AND CHOICE BASED CREDIT SYSTEM (CBCS)
(2022 SCHEME: EFFECTIVE FROM THE ACADEMIC YEAR 2025 – 26)

VIII SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD) and 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	INT	RA822C1R	Internship (14-20 Weeks) [Research Internship/ Rural Internship/ Industry Internship]	RA	00	00	20	00	3	100	100	200	10
2	SEM	RA822S2R	Research oriented Technical Seminar	RA	00	00	03	00	3	100	---	100	2
													12

Note: INT: Internship

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 department.

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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 2022 - 2023)

SEMESTER - III

Course Code	**MA322T1R**	**CIA Marks**	**50**
Number of Contact Hours/Week (L:T:P:S)	**3:0:0:1**	**SEE Marks**	**50**
Total Hours of Pedagogy	**50 L**	**Exam Hours**	**3 Hours**

CREDITS – 3

Prerequisites:

- Applied Mathematics-I, Applied Mathematics-II

Course Objectives:

- Enable the students to use the concepts of Fourier series and transforms to solve engineering problems
- Study the various methods of Transform Calculus of continuous and discrete variables.
- Develop the accurate solutions for initial value problems and Partial Differential Equations using various Numerical Techniques.
- 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 - 1

Module Contents	Lecture Hours
Fourier series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions and arbitrary period. Half-range Fourier series. Practical harmonic analysis and applications. ***Textbook : Chapter 10 (10.1-7,10.11)***	**10 Hours**

MODULE - 2

Fourier transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Application of Fourier Transforms. **Z-Transforms:** Standard z-transforms, damping and shifting rules, initial value and final value theorems (without proof) and problems. Inverse z-transform and Applications to the solution of difference equations. Standard z-transforms, Damping and shifting rules, Inverse z-transform,	**10 Hours**

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and applications to solve difference equations. ***Textbook : Chapter 22 (22.1-5), Chapter 23 (23.1-12,23.16).***	
MODULE - 3	
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 ODE's:** Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae). ***Textbook : Chapter 32 (32.1,3,5,7,8,9,10,12,)***	**10 Hours**
MODULE - 4	
Numerical Solution of Partial Differential Equations: Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank- Nicholson method, Solution of the Wave equation. Application of Partial Differential Equations. ***Textbook : Chapter 33 (33.1-5,7-10)***	**10 Hours**
MODULE - 5	
Linear Algebra: Vector spaces and Null subspaces, Rank and Row reduced form, Independence, Basis and dimension, Dimensions of the subspaces, Rank-Nullity Theorem, Linear Transformations. **Orthogonality**: Orthogonal Vectors and Subspaces, Projections and Least squares, Diagonalization, quadratic forms, Singular value decomposition., Application of Linear Algebra. ***Textbook : Chapter 3 (3.1.3.5,3.8)***	**10 Hours**

COURSE OUTCOMES

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

CO No.	Description	Bloom's Taxonomy Level
CO1	Illustrate the behavior of Fourier series and their applications in communication system.	CL3
CO2	Use the Z transform to solve the difference equations and illustrate the behavior of the Fourier transform and its applications in communication systems.	CL3
CO3	Solve first and second order ordinary differential equations using single-step and multistep numerical methods engineering problems	CL3
CO4	Solve Partial differential equations arising in engineering problems using Standard Numerical methods.	CL3
CO5	Apply matrix operations, solve robotics problems, and analyze systems using orthogonality.	CL3

CO-PO-PSO MAPPING

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

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2									1	1		
CO2	2	2	1										1		
CO3	3	2	2												1
CO4	3	3	1									1		1	
CO5	3	3	1									1			1

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

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				
	40%	**30%**	**30%**	**100 %**	**100%**
CO1	x			x	x
CO2	x	x		x	x
CO3		x		x	x
CO4			x	x	x
CO5			x	x	x

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**

Assignment Types:

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

SEE Question Paper Pattern:

- The question paper will have **TEN** full questions.
- Each full question consists of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of three sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th Ed., 2017, May.
2. N.P Bali and Manish Goyal: "A Textbook of Engineering Mathematics" Laxmi Publications, 10th Ed., 2022
3. E. Kreyszig: "Advanced Engineering Mathematics",JohnWiley&Sons, 10thEd.(Reprint), 2016.
4. James F Epperson: An Introduction to Numerical Methods and Analysis,Wiley Publishers, Third Edition.
5. David C lay, " Linear Algebra and its Application " Cambridge university Press 3rd Edition 2017.

Reference Books:

1. B.V. Ramana: "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed., 2017
2. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw – Hill Book Co., New York, 6th Ed., 2017.
3. E.Kreyszig: "Advanced Engineering Mathematics", John Wiley and Sons, 10thEd.(Reprint), 2016.
4. Dr. K Chandrashekar, "Transform Calculus and Numerical Techniques" Sudha Publications,2019.
5. H.K.Dass and Er. Rajnish Verma: "Higher Engineering Mathematics" S.Chand Publication (2014).

Reference Web Links and Video Lectures (e - Resources):

1. http://www.class-central.com/subject/math(MOOCs)
2. http://academicearth.org/
3. http://www.bookstreet.in.
4. VTU e-Shikshana Program

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5. **https://youtu.be/6HeQc7CSkZs**

6. **https://youtu.be/B4IyRw1zvvA**

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DATA STRUCTURES

(Effective from the Academic Year 2022 - 2023)

III SEMESTER

Course Code	**CS322I2R**	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 C programming basics.

COURSE OBJECTIVES:

- Explain fundamentals of data structures and their applications essential for programming/problem-solving.
- Illustrate linear representation of data structures: Stacks, Queues, Lists, Trees and Graph's.
- Demonstrate sorting and searching algorithms.
- Find suitable data structure during application development/Problem Solving.

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 — **8 Hours**

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. Multidimensional Arrays, Polynomials and Sparse Matrices. Strings: Basic Terminology, Storing, Operations and Pattern Matching algorithms.

MODULE - II

Stacks and Queues — **8 Hours**

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, A Mazing Problem. Multiple Stacks and Queues. Programming Examples

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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, Sparse matrix representation.	**8 Hours**
MODULE - IV	
Trees: Introduction, Binary Trees, Binary Tree Traversal, Additional Binary Tree Operations', Threaded Binary Trees, Binary Search Trees: Definition, searching a BST, Insertion, Deletion, Joining and Splitting Binary Search Trees - Definition, Insertion, Deletion, Traversal, Searching, Application of Trees-Evaluation of Expression, Programming Examples	**8 Hours**
MODULE - V	
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: Insertion Sort, Radix sort, Address Calculation Sort. Hashing: Hash Table organizations, Hashing Functions, Static and Dynamic Hashing.	**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		
CO2		
CO3		
CO4		
CO5		

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Design, Develop and Implement a menu driven Program in C for the following array operations. a. Creating an array of N Integer Elements. b. Display of array Elements with Suitable Headings. c. Inserting an Element (ELEM) at a given valid Position (POS). d. Deleting an Element at a given valid Position (POS). e. Exit. Support the program with functions for each of the above operations		
2.	Design, Develop and Implement a menu driven Program in C for the following operations on STACK of Integers (Array Implementation of Stack with maximum size MAX) a. Push an Element on to Stack		

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	b. Pop an Element from Stack c. Demonstrate how Stack can be used to check Palindrome d. Demonstrate Overflow and Underflow situations on Stack e. Display the status of Stack f. Exit Support the program with appropriate functions for each of the above operations		
3.	Design, Develop and Implement a menu driven Program in C for the following operations on, Circular QUEUE of Characters (Array Implementation of Queue with maximum size MAX) a.Insert an Element on to Circular QUEUE. b. Delete an Element from Circular QUEUE c. Demonstrate Overflow and Underflow situations on Circular QUEUE d. Display the status of Circular QUEUE e. Exit. Support the program with appropriate functions for each of the above operations		
4.	Design, Develop and Implement a menu driven Program in C for the following operations on Singly Linked List (SLL) of Student Data with the fields: USN, Name, Programme, Sem, PhNo a. Create a SLL of N Students Data by using front insertion. b. Display the status of SLL and count the number of nodes in it. c. Perform Insertion / Deletion at End of SLL. d. Perform Insertion / Deletion at Front of SLL(Demonstration of stack). e. Exit		
5.	Design, Develop and Implement a Program in C for the following operationson Singly Circular Linked List (SCLL) with header nodes a. Represent and Evaluate a Polynomial P(x,y,z) = 6x2 y 2 z-4yz5 +3x3 yz+2xy5 z-2xyz3 b. Find the sum of two polynomials POLY1(x,y,z) and POLY2(x,y,z) and store the result in POLYSUM(x,y,z) Support the program with appropriate functions for each of the above operations		
6.	Design, Develop and Implement a Program in C for the following operationson Singly Circular Linked List (SCLL) with header nodes a. Represent and Evaluate a Polynomial P(x,y,z) = 6x2 y 2 z-4yz5 +3x3 yz+2xy5 z-2xyz3 b. Find the sum of two polynomials POLY1(x,y,z) and POLY2(x,y,z) and store the result in POLYSUM(x,y,z) Support the program with appropriate functions for each of the above operations		

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7.	Design, Develop and Implement a Program in C for the following operations on Graph(G) of Cities a. Create a Graph of N cities using Adjacency Matrix. b. Print all the nodes reachable from a given starting node in a digraph using DFS/BFS method		
8.	Given a File of N employee records with a set K of Keys (4-digit) which uniquely determine the records in file F. Assume that file F is maintained in memory by a Hash Table (HT) of m memory locations with L as the set of memory addresses (2-digit) of locations in HT. Let the keys in K and addresses in L are Integers. Design and develop a Program in C that uses Hash function H: K⟶L as H(K)=K mod m (remainder method), and implement hashing technique to map a given key K to the address space L. Resolve the collision (if any) using linear probing		

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														
CO2														
CO3														
CO4														
CO5														

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.

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- 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.

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman: Introduction to Automata Theory, Languages and Computation, 3rd Edition, Pearson Education, 2013. **(Chapters: 1, 2, 3, 4, 5, 6, 7)**
1. K L P Mishra, N Chandrasekaran, 3rd Edition, Theory of Computer Science, PhI, 2012. **(Chapters: 9, 10, 12)**

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

1. Data Structures using C, A M Tenenbaum, PHI, 1989

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MATERIAL SCIENCE AND MANUFACTURING

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	**ME322I3R**	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.	**8 Hours**

MODULE - II

Introduction to smart materials Brief description of materials such as optical, thermal materials, Smart materials– fibre optic materials, Closed loop and Open Loop Smart Structures. Applications of Smart structures, piezo-electric materials and properties. Shape memory alloy and super elasticity, Shape memory Effect-Application, Processing and characteristics. 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	**8 Hours**

MODULE - III

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.	**8 Hours**

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Electro rheological and Magneto Rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids	

MODULE - IV

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 Advanced Welding Processes: Classification, Advantages & limitations of welding. Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes (AHW), Resistance welding, Applications	**8 Hours**

MODULE - V

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.	**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 concept of atomic packing factor and be able to describe mechanical behavior of materials	CL3
CO2	Gain knowledge on smart materials and composites, their processing methods, advantages, challenges and applications	CL3
CO3	Understand the knowledge of the mechanical behavior of ceramics and polymers, ER and MR fluids their processing and applications	CL3
CO4	Describe and classify the casting, metalworking and welding process, their advantages, applications and limitations	CL3
CO5	Classify the various nontraditional machining process process principle, application, advantages and limitation and further to gain working principles of various nontraditional machining process	CL2

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Evaluate the hardness of untreated and treated specimens using Brinell, Rockwell and Vickers's Hardness testing machine	CO3	CL3
2.	Evaluate mechanical properties using Universal Testing Machine	CO3	CL3
3.	Izod and Charpy test for untreated and treated specimens	CO3	CL3
4.	Fabrication of Fibre reinforced polymer composites using hand lay-up methods (Demonstration)	CO3	CL3
5.	Preparation of sand mould using hand cut molds	CO3	CL3
6.	Preparation of welded joints using Arc Welding equipment and robotic welding: TJoint, Butt joint, Lap joints on M.S. flats	CO4	CL3
7.	Demonstrations on Preparation of hexagonal bolt and hook through forging	CO4	CL3

CO-PO-PSO MAPPING

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

- 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.
- Workshop Technology Vol I & II, Hajra Choudhary, Media Publishers, Bombay, 2004.

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- 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, Serope kalpakjain Steuen.R.Sechmid, Pearson Education Asia, 5th Edition 2006. 21 4. Smart Structures : Analysis and Design -A.V.Srinivasan,Cambridge university Press,Cambridge; New York 2001
- Plastics Engineering- RJ Crawford, 3rd Edition, Butterworth Heinemann 1998

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

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MECHANICS OF MATERIALS

(Effective from the Academic Year 2023 - 2024)

SEMESTER - III

Course Code	ME322T4R	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 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, Super position 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.	**08 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 tress, Mohr circle for plane stress conditions. **Cylinders**: Thin cylinder: Hoop's stress, maximum shear stress, Circumferential and longitudinal strains, thick cylinders: Lames equations.	**08 Hours**

MODULE - III

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed constant / varying loads. **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.	**08 Hours**

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MODULE - IV	
Torsion: Circular solid and hallow 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.	**08 Hours**
MODULE - V	
Strain Energy: Castigliano's theorem I and II, Load deformation diagrams, strain energy due to normal stresses, Shear stresses, Modulus of resilience, Strain energy due to bending and torsion. **Theories of Failure**: Maximum Principal stress theory, Maximum shear stress theory.	**08 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
CO5	Analyze the concept of Strain energy and theories of failure for the efficient design of engineering materials.	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		
CO5	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**

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%

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CO1	x			x	x
CO2	x	x		x	x
CO3		x		x	x
CO4			x	x	x
CO5			x	x	x

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. 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):

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

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MACHINE DRAWING AND GD&T

(Effective from the Academic Year 2023 - 2024)

SEMESTER - III

Course Code	**ME322L5R**	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 visualization.
- 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.
- Acquire the knowledge of thread forms, fasteners, keys, joints and couplings.
- 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
- 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

PRE-REQUISITE EXPERIMENTS

1. Drawing orthographic views of a machine part.
2. Creating 3D model of simple solid parts.

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. C Clamp
4. Cross head
5. IC engine connecting rod
6. Crane hook
7. Lifting devices
8. Lever safety valve

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PART B

1. Sheet metal modelling and assembly (Exercise Problems)
2. Robotic gripper 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 suitable GD&T symbols to the machine part drawings.	CL 3
CO2	Analyze 2D part drawings and generate 3D assembly of machine components using CAD software.	CL 4
CO3	Develop production drawing of a machine component as per GD&T standards.	CL 3
CO4	Model sheet metal drawings using CAD software.	CL 3
CO5	Develop robotic grippers using CAD software.	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	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 Report (A)	50 %	25
	Laboratory Test (B)	50 %	25
2	**Semester End Examination (SEE)**	**100 %**	**50**

ASSESSMENT STRATEGY:

- CIA shall be evaluated for max marks 100. 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.
- Marks distribution for test is PART A + PART B = 60 + 40

SEE QUESTION PAPER PATTERN:

- SEE shall be conducted and evaluated for maximum marks 100. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- The question paper will include two questions from each part i.e from Part A and Part B. Student has to answer one question each from part.
- Marks distribution: PART A + PART B = 60 + 40
- The duration of SEE is 03 hours.

REFERENCE BOOKS:

1. K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition, 2006.
2. N D Bhatt, "Machine Drawing", Charotar Publishing House Pvt. Ltd.,50th Edition, 2014.

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3. James D. Meadows, "WORKBOOK AND ANSWERBOOK for Geometric Dimensioning and Tolerancing", [As per ASME Y14.5-2009], 2009.
4. K R Gopalakrishna, "Machine Drawing", Subhash publications, 20th edition, 2007.
5. P S Gill, "Geometric Dimensioning & Tolerancing", S.K. Kataria & Sons, 3rd edition, 2019.

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

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

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INTRODUCTION TO ROBOTICS

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	**RA322T6R (A)**	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
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

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.	**8 Hours**
MODULE - II	
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. **3D Homogeneous transformations:** 3D homogeneous rotation Matrix, 3D Homogeneous translation Matrix, Composite rotation Matrix, Rotation Matrix about an Application of 3D homogeneous transformations in robotics, numerical problems.	**8 Hours**
MODULE - III	
Sensors used in Robots: 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 for Robots:** Classification - Electric, Hydraulic, Pneumatic actuators, their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, selection of motors; Hydraulic actuators - Components and typical circuit, advantages, and disadvantages; Pneumatic actuators - Components and typical circuit, advantages and disadvantages.	**8 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.	**8 Hours**
MODULE - V	
Robot applications: Industrial Applications - Manufacturing, Assembly Automation, Machining, Drilling,	**8 Hours**

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Welding, Painting. Consumer Applications. Emerging Applications - Mobile Robots, Medical Robots, Soft Robots, Collaborative Robots, Cloud Robots, Micro robots, Tele Robots, AGVs, Underwater Robots, Robotics and AI, RPA, Economic and Social Aspects of Robots.	

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 components of robots and their classification.	CL2
CO2	Explain different types of end effectors and 3D homogeneous transformations applied to robotics.	CL2
CO3	Describe the applications of sensors and actuators in robotics.	CL2
CO4	Explain the robot programming techniques.	CL2
CO5	Discuss the diverse applications of robots.	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		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

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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. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, NewDelhi, 2003.
2. Mikell. P. Groover, “Industrial Robotics Technology”, Programming and Applications, McGraw Hill Co, 1995.
3. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education, 2014.
4. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2019.

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

1. https://nptel.ac.in/courses/112105249

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UHV -1:SOCIAL CONNECT & RESPONSIBILITIES

(Effective from the Academic Year 2021 - 2022)

SEMESTER III

Course Code	**HU32287X**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Exam Hours	03

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.	**3 Hours**

MODULE - II

Heritage walk 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.	**3 Hours**

MODULE - III

Organic farming and waste management: Introduction of organic farming, study on wet waste management, Effects of organic farming on crop productivity.	**3 Hours**

MODULE - IV

Water Conservation: Necessity of water conservation, study on water reuse, an overview on rainwater harvesting. Activity: Documentary or photo blog presenting the current practices.	**3 Hours**

MODULE - V

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Food Practices: Fast foods - nutritional value, food lore and indigenous materials of the region used in cooking.	**3 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	CL3
CO4	To know the importance and necessity of Water Conservation	CL3
CO5	To understand diverse food practices of the region.	CL3

CO-PO-PSO MAPPING

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

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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:

- The question paper will have **seventy MCQ** questions and **six** main questions.
- Each MCQ questions consisting of 1mark; and main questions of 5 marks.
- Main questions will be asked from all FIVE modules.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,New Delhi, 2010

REFERENCE BOOKS:

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.

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

https://www.aicteindia.org/sites/default/files/Vol.%20II%20%20AICTE%20UG%20%20Curriculum.

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PYTHON FOR SCIENTIFIC COMPUTING

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	**RA32298RA**	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
- Basic Knowledge of programming and control loop concepts studied in C Programming of 1ST year BE.

COURSE OBJECTIVES:

- To apply Python for computational problems in engineering.
- To capture data, process data and interpret the results using graphs in Python.

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	Demonstrate Python ,IDEs of Python environment, mathematical expressions with numbers, Variables, symbol constants, functions and help writing a basic program and elements. (1hr) Students develop and execute a basic program in a Python IDE,Additional features of Ipython Interpreter (1hr)
2	Demonstrate and conduct plotting scientific graphs using Matplotlib library and different plotting functions. Students plot different graphs using Matplotlib library (2hrs)
3	Demonstrate and conduct Loading data from files, plotting charts (2hrs)
4	Demonstrate and conduct For loop, lists and String functions (2hrs)
5	Demonstrate and conduct file handling functions, parsing data and statistical functions (2hrs)
6	Demonstrate and conduct Array Operations ,Image manipulation with arrays (2hrs)
7	Demonstrate Basic matrix operations. (1hr) Students develop and execute the basic matrix operations in a Python IDE. (1hr)
8	Demonstrate advanced matrix operations (1hr) Students develop and execute the advanced matrix operations in a Python IDE.(1hr)
9	Demonstrate control loops - if, else, elseif, select, for loop, while loop with suitable examples(1hr)

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	Students develop and execute the control loop operations in a Python IDE. (1hr)
10	Demonstrate script and function programming concepts with suitable examples(1hr) Students develop a script and function program to perform a particular given task(1hr)
11	Demonstrate Generating a Least Square fit line Generating L vs t square loadtxt function ,Usage of numpy library Plotting L vs t square Steps for least square fit line Matrix formulation . (1hr) Students to solve a least square fit line and plot . (1hr)
12	Capstone Project on implementation of Python programming concepts –Students has to develop miniature software/program using python for an engineering problem.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand and execute basic python commands using different IDEs and python libraries and their use	CL 4
CO2	Plot scientific graphs for data visualization using python libraries	CL 4
CO3	Execute file handling functions, arrays and matrix operations for scientific computing	CL 4
CO4	Execute control loops, function programming and script programming	CL 4
CO5	Build a miniature software/program using python to solve an engineering problem	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	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 (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.

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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. Spoken Tutorials Python programming - . **https://spoken-tutorial.org/tutorial-search/?search_foss=Python%203.4.3&search_language=English&page=1**

2. Let Us Python , Y .Kanetkar and A.Kanetkar , BPB Publications ,4th Edition ,2021.

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GENERATIVE DESIGN LAB

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	**RA32298RB**	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 parametric 3D CAD tool , preferably Fusion 360
- Basic knowledge of Engineering drawings

COURSE OBJECTIVES:

- To familiarise 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
- 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	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

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	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	Explain generative design technology and Edit sculpted bodies using T-splines using Autodesk Fusion 360.	CL3
CO2	Create basic assemblies using Autodesk Fusion 360. .	CL5
CO3	Use generative design using Autodesk Fusion 360.	CL4
CO4	Explore generative design outcomes using Autodesk Fusion 360.	CL4
CO5	Finalize advanced designs using Autodesk Fusion 360	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	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 (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).

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- 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. Introduction to Generative Design for Manufacturing
https://www.autodesk.com/certification/learn/course/fusion360-generative-design-intro-expert

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EMBEDDED SYSTEMS LAB

(Effective from the Academic Year 2022 - 2023)

III SEMESTER

Course Code	**RA32298RC**	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.

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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.

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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):

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GAME DESIGN LAB

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	**RA32298RD**	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.

COURSE OBJECTIVES:

- To know the basics of 2D and 3D graphics for game development.
- To know the stages of game development.
- To understand the basics of game engine.
- To survey the gaming development environment and toolkits.
- To learn and develop simple games using Pygame environment.

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	Installation of a game engine, familiarization of the GUI. Conceptualize the theme for a 2D game.
2	Character design, sprites, movement and character control.
3	Level design: design of the world in the form of tiles along with interactive and collectible objects.
4	Design of interaction between the player and the world, optionally using the physics engine.
5	Developing a 2D interactive game.
6	Developing a Puzzle game.
7	Developing a Board game.
8	Design of menus and user interaction in mobile platforms.
9	Developing a 3D Game using unity.
10	Developing a Multiplayer game using unity.

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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 concepts of 2D and 3D graphics.	CL2
CO2	Know about games and their genres with their origin and history.	CL2
CO3	Prepare game design documents.	CL3
CO4	Demonstrate the implementation of gaming engines.	CL3
CO5	Develop a 2D/3D game using unity game engine.	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	3		
CO2	3	2			2					2		2	3		
CO3	3	2			2					2		2	3		
CO4	3	2			2					2		2	3		
CO5	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**
	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)

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- 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. Nystrom Robert, Game Programming Patterns, 3rd edition, Genever Benning, 2014.
2. Paris Buttfield Addison et al., Unity Game Development Cookbook: Essentials for Every Game, 1st Edition, O'Reilly Media, 2019.
3. David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, CRC Press, 2006.
4. Jung Hyun Han, "3D Graphics for Game Programming", Chapman and Hall/CRC, 2011.

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ANALOG AND DIGITAL ELECTRONIC CIRCUITS

(Effective from the Academic Year 2022 - 2023)

IV SEMESTER

Course Code	**EC422I1R**	CIA Marks	50
Number of Contact Hours/Week (L: T:P:S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 L + 20 P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of pre-university level physics and basics of electronics.

COURSE OBJECTIVES:

This course will enable students to:

- Characteristics of JFETs and MOSFETs
- Demonstrate and Analyze Operational Amplifier circuits and their applications
- Combinational Logic circuits, Simplification of Algebraic Equations using Karnaugh Maps and Quine McClusky Techniques.
- Decoders, Encoders, 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:

These are some sample strategies; which course faculty members can incorporate into the Teaching-Learning Process:

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

COURSE CONTENTS

MODULE - I

Field Effect Transistors: Junction Field Effect Transistors, MOSFETs, Differences between JFETs and MOSFETs, Biasing MOSFETs, FET Applications, CMOS Devices. Wave-Shaping Circuits: Integrated Circuit (IC) Multivibrators. **Introduction to Operational Amplifier**: Ideal v/s Practical Op Amp, Performance Parameters, Operational Amplifier Application Circuits: Peak Detector Circuit, Comparator, Active Filters, Relaxation Oscillator.	**8 Hours**

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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 map Simplifications, Don't-care Conditions, Product-of-sums Method, Product-of- sums simplifications, Simplification by Quine-McClusky Method, HDL Implementation Models.	**8 Hours**
MODULE - III	
Data Processing Circuits: Multiplexers, Demultiplexers, 1-of-16 Decoder, BCD to Decimal Decoders, Seven Segment Decoders, Encoders, Parity Generators and Checkers, Magnitude Comparator, Programmable Array Logic, Programmable Logic Arrays, HDL Implementation of Data Processing Circuits. Arithmetic Building Blocks, Arithmetic Logic Module.	**8 Hours**
MODULE - IV	
Flip-Flops: Flip flop Timing, JK Master-slave Flip flop, Switch Contact Bounce Circuits, Various Representation of Flip flops, HDL Implementation of Flip flop. **Registers:** Types of Registers, Serial In - Serial Out, Serial In – Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Universal Shift Register, Applications of Shift Registers, Registers implementation in HDL.	**8 Hours**
MODULE - V	
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:** Variable Resistor Networks, Binary Ladders, D/A Converters, D/A Accuracy and Resolution, A/D Converter-Simultaneous Conversion, A/D Converter-Counter Method, Continuous A/D Conversion, A/D Techniques, Dual slope A/D Conversion, A/D Accuracy, and Resolution.	**8 Hours**

COURSE OUTCOMES

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

CO No.	Course outcomes 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 in digital circuits.	CL3
CO5	Study variety of ADCs, DACs and counters 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

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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.	CO3	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	CO4	CL3
8.	Construct a Universal Shift register using a suitable IC	CO4	CL3
9.	Develop Mod-5 Counter using JK Flip flop.	CO5	CL3
10.	Operate Mod N Synchronous Up Counter and Down Counter using JK Flip- flop.	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	3	2		3			2	2	2		2		2	2
CO2	3	2	2		3			2	2	2		2		2	2
CO3	3	2	2		3			2	2	2		2		2	2
CO4	3	2	2		3			2	2	2		2		2	2
CO5	3	2	2		3			2	2	2		2		2	2
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

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

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	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

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40%	30%	30%	100%	100%
MI		MI	MI	MI
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. "Electronic Devices and Circuits", A.K. Maini & Varsha Agarawal., Wiley India Pvt. Ltd.
2. "Digital Principles and Applications", Donald P Leach, Albert Paul Malvino & Gautam Saha, 8th Edition, McGraw Hill Education (India) Private Limited.
3. Digital Electronics, William Kleitz, Prentice Hall International Inc.
4. Electronics analog and digital, Nagrath, I J, New Delhi Prentice-Hall of India 1999.

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

1. https://www.youtube.com/playlist?list=PLbRMhDVUMngehqNF2w_UbAi94qIycZOTG
2. https://www.youtube.com/playlist?list=PLbRMhDVUMnge4gDT0vBWjCb3Lz0HnYKkX

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INSTRUMENTATION AND CONTROL SYSTEMS

(Effective from the Academic Year 2023 - 2024)

IVSEMESTER

Course Code	**RA422I2R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40L + 20P	Exam Hours	03

CREDITS – 4

COURSE PREREQUISITES:

- Knowledge of mechatronics and basics of mathematical modelling

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.

8 Hours

MODULE - II

Data Acquisition Systems

A/D and D/A converters, Plug-in Analog Input / Output cards – Digital Input and Output Cards, Organization of the DAQ VI system – 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 – Design of digital voltmeter with transducer input

8 Hours

MODULE - III

Virtual Instrumentation

Block diagram and Architecture for Virtual Instruments versus Traditional Instruments Instrumentation -VI Programming techniques - VI, sub VI, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output

8 Hours

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MODULE - IV	
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.	**8 Hours**
MODULE - V	
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)	**8 Hours**

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom'sTaxonomy Level
CO1	Identify the types of transducers and measurement system for measuring applications.	CL3
CO2	Organize the DAQ systems using sensor, timers and counters.	CL3
CO3	Analyze the Virtual instrumentation using in VI software.	CL4
CO4	Distinguish the open and closed type of controllers and time domain control systems.	CL4
CO5	Analyze the control systems with the aid of block diagram reduction, signal flow graphs, and frequency response diagrams.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Demonstration of the measurement system and its static characteristics, error calculations of different types of errors	CO1	CL3
2.	Demonstration and hands-on measurement of measurands using transducer connected to DAQ/CRO with output interpretation	CO1	CL3
3.	Demonstration and hands-on measurement of different physical parameters using different types of sensors.	CO2	CL3
4.	Hands-on design of digital voltmeter with transducer input –Timers and Counters	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. Model file will be evaluated for assignment.	CO3	CL3
6.	Demonstration on interfacing of a DAQ with a VI Software and measurement of three or four physical parameters followed by interpretation of the results.	CO3	CL3
7.	Demonstration and hand-on exercise on modelling of physical systems using Scilab/Python	CO4	CL3
8.	Case study of PID Controller.	CO4	CL2
9.	Demonstration of Graphical modelling of physical system using Scilab-Xcos/OpenModelica/other system modelling software	CO5	CL3
10.	Graphical programming assignment to the student after the demonstration.	CO5	CL3

CO-PO-PSO MAPPING

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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		
CO5	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)	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
		MIII	MIII	MIII
MIV			MIV	MIV
MV	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.

TEXT 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

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REFERENCE BOOKS:

1. Virtual Instrumentation using LABVIEW, Sanjay Gupta, McGraw Hill, 2017
2. Hands on Lab View for Scientists and Engineers, Essick, Oxford University Press, 2013
3. Engineering Metrology and Measurements
4. N.V. Raghavendra, L.Krishnamurthy, Oxford Higher Education, 2013
5. Modern Control Engineering, K. Ogata, Pearson Education India, 2015

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

1. Engineering Metrology, By Prof. J. Ramkumar,IIT Kanpur -NPTEL Course https://onlinecourses.nptel.ac.in/noc20_me94/preview
2. Control Engineering by Prof.Hithesh D. - Engineering Funda- https://www.youtube.com/watch?v=KBy3ISlCES4&list=PLgwJf8NK-2e43et6qbo4IqYSJCv-6kN90
3. Getting Started with Labview –by NI Apps -https://www.youtube.com/playlist?list=PLB968815D7BB78F9

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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

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THEORY OF MACHINES

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	**ME422T3R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:2	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Knowledge of Gears and Gear drives, Belt drives and Rope drives from Elements of Mechanical engineering

COURSE OBJECTIVES:

- Describe the basics terminologies of kinematics, mechanisms and machines, working of the mechanisms, inversions of the mechanisms, lower pair mechanisms.
- Describe the basics terminologies of kinematics, mechanisms and machines, working of the mechanisms, inversions of the mechanisms, lower pair mechanisms.
- Analyse the velocity and acceleration of the different planar mechanisms analytically and create kinematic synthesis of mechanisms using analytical approaches.
- Analyse and design the different types of belt drives, chain drives and brakes.
- Describe the terminologies of spur gears and gear trains.
- Apply the formulae to calculate gear parameters such as length of path and arc of contact, contact ratio.
- Describe the various types of cams and Create Cam drawings according to the requirements using displacement diagrams, Determine Cam velocity and accelerations.
- To Analyse and design the different types of governors. Analyse the balancing of revolving and reciprocating masses.

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

COURSE CONTENTS

MODULE - I

Basics of 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, Transmission Angle, Chebychev–Grübler–Kutzbach criterion, Grasshof's criteria. **Mechanisms with Lower Pair:**Pantograph, Straight Line Mechanisms, Automobile Steering Gears.	**8 Hours**

MODULE - II

Velocity and Acceleration Analysis of Mechanisms: Absolute and Relative Motion, Velocity and Acceleration Diagrams for four bar mechanisms. **Velocity by Instantaneous Centre Method:**Arnold-Kennedy Theorem, Klein Construction.	**8 Hours**

MODULE - III

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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.	**8 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). **Cams**: Types of Cams and Followers, Cam Terminology, Cam Profile Layout with knife-edge, roller follower including SHM and UARM	**8 Hours**

MODULE - V

Governors: Types & functions. **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.	**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 working of Kinematic Mechanism and its Inversions.	CL2
CO2	Analyze the Velocity and Acceleration of the planar Mechanisms.	CL4
CO3	Analyze the different types of Belt drives, chain drives and Brakes.	CL4
CO4	Analyze Gears, gear trains and create a CAM profile using SHM and UARM motions.	CL4
CO5	Analyze the different types of Governors, Balancing of rotating and Reciprocating masses.	CL4

CO-PO-PSO MAPPING

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

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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
	MIII		MIII	MIII
MIV	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	25 %	05
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. 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
3. Theory of Machine And Mechanisms Si Edition, John J. Uicker, Gordon R. Pennock& Joseph E. Shigley, Oxford University Press, 4th Edition,2014
4. Kinematic Synthesis of Linkages, R. Hartenburg, J. Denavit, F. Freudenstein, McGraw Hill, 1964
5. Theory of Machines: Kinematics and Dynamics, Sadhu Singh, Pearson Education India, 3rd edition ,2011.

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

1. NPTEL – Theory of Mechanisms - https://nptel.ac.in/courses/112106270
2. NPTEL - Kinematics of Mechanisms and Machines - https://www.youtube.com/watch?v=yDEJxYGAoso&list=PLbRMhDVUMngdCkMipemSKP_dCgZLLfOe8

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OBJECT ORIENTED PROGRAMMING WITH C++

(Effective from the Academic Year 2023 - 2024)

SEMESTER - IV

Course Code	CS422T4R	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
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

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.	**8 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 <<, >>.	**8 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	**8 Hours**
MODULE –IV	
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.	**8 Hours**
MODULE –V	

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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	**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 OOPs Concept, C++ language features, various Datatypes and Operators.	CL2
CO2	Understand the concepts of Classes &Objects, friend function , constructors & destructors in program design.	CL2
CO3	Demonstrate various forms of inheritance and base class constructors.	CL3
CO4	Demonstrate operator overloading, runtime polymorphism and Generic Programming.	CL3
CO5	Demonstrate various Stream classes, I/O operations and exception handling.	CL3

CO-PO-PSO MAPPING

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

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.

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ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Field Visits/Survey/Case Studies	50 %	10
4	Model / Prototype Development	100 %	20
5	Project Based Learning		
6	Seminar/Presentation	25 %	5
7	Peer - to -Peer Learning	25 %	5

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.
- Each full question consisting of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1.

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.

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

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CNC and 3D Printing Lab

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	**ME422L5R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of 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
- 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	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 product on an available AM machine.
8	Post processing of additively manufactured product (micro machining, cavity cleaning and some secondary operations)

Demonstration Experiments

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9	Simulation of Stereolithography Process Simulation of Fused Deposition Modelling (FDM) Process
10	Simulation of Selective Laser Sintering (Non-Metal) Process Simulation of Selective Laser Sintering (Metal) Process Simulation of Post-processing in Additive manufacturing Simulation of Pre-processing in Additive manufacturing

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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 (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.

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III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)
   - The respective course instructor will design the assessment criteria for the said assessment components.
   - The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

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

SEE QUESTION PAPER PATTERN:

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

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

1. https://3dp-dei.vlabs.ac.in/
2. https://nptel.ac.in/courses/112103306
3. https://3dp-dei.vlabs.ac.in/exp/simulation-stereolithography-process/
4. https://3dp-dei.vlabs.ac.in/exp/simulation-modelling-process/
5. https://3dp-dei.vlabs.ac.in/exp/simulation-laser-sintering-nonmetal/
6. https://3dp-dei.vlabs.ac.in/exp/simulation-laser-sintering-metal/
7. https://3dp-dei.vlabs.ac.in/exp/simulation-post-processing/
8. https://3dp-dei.vlabs.ac.in/exp/simulation-additive-manufacturing/

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Statistical Methods and Probability Theory

(Effective from the Academic Year 2022 - 2023)

SEMESTER - IV

Course Code	**MA422T6R**	**CIA Marks**	**50**
Number of Contact Hours/Week (L:T:P:S)	**3:0:0:1**	**SEE Marks**	**50**
Total Hours of Pedagogy	**50 L**	**Exam Hours**	**3 Hours**

CREDITS – 3

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

COURSE OBJECTIVES:

- Study the techniques of complex variables and functions together with their derivatives, Contour integration and transformations
- Enable the students to apply basic concepts Testing Hypothesis
- Understand the concept of probability distributions and enable the students to predict the outcome of simple random experiments
- Understand methods for solving linear systems, Explore quadratic forms and their applications in mathematical and engineering contexts.

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

Calculus of Complex functions & Construction of Analytic 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. ***Textbook : Chapter 20(sections :20.1,20.2,20.3,20.4,20.5)***	**10 Hours**

MODULE - II

Linear system of equations : consistent and inconsistent systems and its solution sets; LU decomposition. **Symmetric Matrices and Quadratic Forms:** Inner products, inner product spaces , orthogonal sets , orthogonal projections, Gram- Schmidt Orthogonalization procedure, QR Factorization. ***Textbook : Chapter 3(sections :3.15, 3.45)***	**10 Hours**

MODULE - III

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Probability Distribution Functions: Discrete and Continuous Random variables, Probability mass function, Probability density functions, Binomial, Poisson distributions-problems. Exponential and Normal distributions-problems. Stachastic Process , Markov Chains. ***Textbook : Chapter 26 (26.7,26.8,26.9,26.10,26.14,26.15,26.16,26.19(section-6))***	**10 Hours**
MODULE - IV	
Sampling and Testing Hypothesis : 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, Probable limits for proportions. ***Textbook : Chapter 27 (27.1-7, 27.12,27.14-18).***	**10 Hours**
MODULE - V	
Curve Fitting and Statistical Methods: Curve fitting by the method of least squares- fitting the curves of the form $y = ax + b$, $y = ax^b$, $y = ae^{bx}$ and $y = ax^2 + bx + c$. Correlation-Karl Pearson's coefficient of correlation regression analysis-lines of regression, Rank Correlation. **Optimization Technique:** Mathematical Modeling of LPP, Graphical method, Simplex Method. ***Textbook : Chapter 24 (24.5,24.6,), Chapter 25(25.12,25.13,25.14), Chapter 34(34.3,34.7)***	**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 calculus principles to construct complex functions, fostering problem-solving skills for mechanical engineering.	CL3
CO2	Apply symmetric matrices, quadratic forms, for real-world problem-solving and mathematical proficiency.	CL3
CO3	Utilize Discrete and Continuous random variables and Probability distribution functions to use for the probability models in engineering field	CL3
CO4	Validate hypothesis testing and apply the Principles of Sampling to infer the nature of population.	CL3
CO5	Use correlation and regression analysis to fit a Mathematical model for statistical data.	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		
CO2	2	2	1									1	1		
CO3	3	2	2					1	1						1
CO4	3	3	1						1			1		1	
CO5	3	3	1					1				1			1

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

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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.

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TEXT BOOKS:

1. W H Hayt and J A Buck, “Engineering Electromagnetics”, Mc Graw Education, 8th Edition, 2014
2. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.
3. S.C Gupta and V.K.Kapoor:Fundamentals of Mathematical Statistics" by, 12th Edition,Sultan Chand & Sons Publications.2012
4. N.P Bali & Dr. Manish Goyal: " Engineering Mathematics" 9th Edition, Laxmi Publications.
5. David C lay, “ Linear Algebra and its Application “ Cambridge university Press 3rd Edition 2017.

REFERENCE BOOKS:

1. C Ray Wylie, Louis C Barrett: “Advanced Engineering Mathematics", 6th Edition,
2. B.V Ramana: "Higher Engineering Mathematics" 11th Edition, Tata McGraw-Hill,
3. E C Jordan and K G Balmain, “Electromagnetic Waves and Radiating Systems “, Pearson, 2nd Edition,
4. Joseph A Edminister, “Electromagnetics”, Schaum’s Outlines, Revised 2nd Edition, 2017.
5. Bernard Kolman and David R. Hill, "Introductory Linear Algebra with Applications”, Pearson Education(Asia) Pte. Ltd, 7th edition, 2003.
6. 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. http://nptel.ac.in/courses.php?disciplineID=111
4. http://www.class-central.com/subject/math(MOOCs)
5. http://academicearth.org/
6. http://www.bookstreet.in.

9.VTU e-Shikshana Program

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Data Wrangling, Analysis and Visualization

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	**RA42297RA**	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 Python as covered in AEC - Python for Scientific Computing
- Basic knowledge of statistics, graphs and linear algebra

COURSE OBJECTIVES:

- To become familiar in the utlisation 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
- 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	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. Tutorial Link: [Pandas Basics](https://pandas.pydata.org/docs/getting_started/intro_tutorials/index.html)
2	Data Transformation with Pandas: Explore more advanced data transformation techniques using Pandas. Perform merging, grouping, pivoting, and reshaping data for analysis. Tutorial Link: [Data Transformation with Pandas](https://pandas.pydata.org/pandas-docs/stable/getting_started/intro_tutorials/06_calculate_statistics.html)
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. Tutorial Link: [Data Cleaning with Regular Expressions](https://www.datacamp.com/community/tutorials/python-regular-expression-tutorial)
4	Handling and Cleaning Messy Data with OpenRefine: Use OpenRefine , a powerful tool for data cleaning and transformation to clean and preprocess data with a user-friendly interface. Tutorial Link: [OpenRefine Tutorial](https://programminghistorian.org/en/lessons/cleaning-data-with-openrefine)
5	Exploratory Data Analysis (EDA) with Seaborn and Matplotlib:Perform exploratory data analysis using Seaborn and Matplotlib libraries. Create differrent types of plots and visualizations to understand data distribution and relationships. Tutorial Link: [EDA with Seaborn and Matplotlib](https://seaborn.pydata.org/tutorial.html)
6	Statistical Data Analysis with SciPy:Perform statistical analysis using the SciPy library. Demonstrate basic statistical tests, hypothesis testing, and summary statistics to analyze datasets.

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	Tutorial Link: [Statistical Data Analysis with SciPy](https://docs.scipy.org/doc/scipy/reference/tutorial/stats.html)
7	Time Series Analysis with Pandas: Analyze time series data using Pandas. Use techniques for resampling, rolling statistics, and plotting time-based data. Tutorial Link: [Time Series Analysis with Pandas](https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html)
8	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. Tutorial Link: [Scikit-Learn Tutorial](https://scikit-learn.org/stable/tutorial/index.html)
9	Data Visualization with Matplotlib:Learn the fundamentals of data visualization using the Matplotlib library. Create different types of plots and customizing visualizations. Tutorial Link: [Matplotlib Tutorial](https://matplotlib.org/stable/tutorials/introductory/pyplot.html)
10	Interactive Data Visualization with Plotly:Explore interactive and web-based data visualization using Plotly. Create dynamic visualizations that can be embedded in web applications. Tutorial Link: [Plotly Python Tutorial](https://plotly.com/python/)
11	Data Visualization with Seaborn: Explore the advanced data visualization using the Seaborn library. Create attractive and informative statistical visualizations. Tutorial Link: [Seaborn Tutorial](https://seaborn.pydata.org/tutorial.html)
12	Geospatial Data Visualization with Geopandas: Use geospatial data and create maps using the Geopandas library. Load geographic data, performing spatial analysis, and generating maps. Tutorial Link: [Geopandas Documentation](https://geopandas.org/docs/user_guide.html)

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply Pandas for data manipulation and analysis- be able to load, clean, transform, and summarize data using Pandas	CL2
CO2	Apply data cleaning tools like Openrefine to handle messy and unstructured data effectively, ensuring data quality and consistency in real-world datasets.	CL2
CO3	Create Data visualisation using Exploratory Data Analysis (EDA) Skills using Seaborn and Matplotlib.	CL2
CO4	Analyse Statistical parameters of data using Scipy - perform hypothesis testing, statistical modeling, and advanced statistical analyses suing SciPy	CL2
CO5	Create geospatial visualizations using Geopandas, as covered in the Geopandas Documentation.	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	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)**

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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. Pandas Basics- https://pandas.pydata.org/docs/getting_started/intro_tutorials/index.html
2. Data Transformation with Pandas- https://pandas.pydata.org/pandas-docs/stable/getting_started/intro_tutorials/06_calculate_statistics.html
3. Data Cleaning with Regular Expressions-https://www.datacamp.com/community/tutorials/python-regular-expression-tutorial
4. Handling and Cleaning Messy Data with OpenRefine-https://programminghistorian.org/en/lessons/cleaning-data-with-openrefine
5. Exploratory Data Analysis (EDA) with Seaborn and Matplotlib- https://seaborn.pydata.org/tutorial.html
6. Statistical Data Analysis with SciPy-https://docs.scipy.org/doc/scipy/reference/tutorial/stats.html
7. Time Series Analysis with Pandas- https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html

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8. Machine Learning for Data Analysis with Scikit-Learn- https://scikit-learn.org/stable/tutorial/index.html
9. Data Visualization with Matplotlib:Learn the fundamentals of data visualization using the Matplotlib library. Create different types of plots and customizing visualizations- https://matplotlib.org/stable/tutorials/introductory/pyplot.html
10. Plotly Python Tutorial- https://plotly.com/python/
11. Seaborn Tutorial- https://seaborn.pydata.org/tutorial.html)
12. Geopandas Documentation- https://geopandas.org/docs/user_guide.html

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PROTOTYPE FABRICATION LAB

(Effective from the Academic Year 2022 - 2023)

IV SEMESTER

Course Code	**RA42297RB**	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.

COURSE OBJECTIVES:

- To understand the design standards of fabrication of industrial components.
- To fabricate the robot components.
- To fabricate the machine components.
- To design the electronic circuits.
- To fabricate the electronic circuits used in various industries.

TEACHING - LEARNING STRATEGY:

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

- Chalk and Talk Method/Blended Mode Method
- Power Point Presentation
- Expert Talk/Webinar/Seminar
- Video Streaming/Self-Study/Simulations
- Peer-to-Peer Activities
- 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	**Design thinking and communication: Problem identification and rational thinking** CAD drawings and standards, Safety standards.
2	**Design thinking and communication: Problem identification and rational thinking** CAM packages- CNC Turning and CNC milling part program generation.
3	**Design for Fabrication**: Learning designing standards for Robo components.
4	**Design for Fabrication**: Learning designing standards for automotive components.
5	**Design for Fabrication**: Learning designing standards for machine members.
6	**Design for Fabrication**: Learning designing standards for weld joints.
7	**Design, plan and create** technically sound and conceptually- related screen printed images using Adobe photoshop and other softwares for 3D printing objects
8	**Learning programming** for virtual prototyping for non conventional machining processes
9	**Design and fabrication of Eletronic circuits**-rectifiers, Simple Temperature Monitor
10	**Design and fabrication of Eletronic circuits**-Touch Sensor Circuit.
11	**Design and fabrication of Eletronic circuits**-Invisible Burglar Alarm
12	**Design and fabrication of Eletronic circuits**-Rain Alarm

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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 design standards of fabrication of industrial components.	CL2
CO2	To fabricate the robot components.	CL4
CO3	To make the machine components.	CL4
CO4	To design the electronic circuits.	CL4
CO5	To fabricate the electronic circuits used in various industries.	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	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

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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://spu.ac.in/fabrication-laboratory/https://www.comasso.org/
2. https://dl.acm.org/doi/10.1145/3335055.3335074

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SENSORS AND ACTUATORS LAB

(Effective from the Academic Year 2022 - 2023)

IV SEMESTER

Course Code	**RA42297RC**	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:

- Mechatronics
- Basics of IOT

COURSE OBJECTIVES:

- To understand the basic working principle and operation of different types of sensors and actuators and their real time applications.
- To know the characteristics performance of mechanical sensors like- high stiffness, high resolution over a wide measurement range.
- To understand different industrial sensors and actuators and their real time applications with Arduino and Raspberry-Pi.

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	To sense the Available Networks Using Arduino.
2	Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
3	To detect the Vibration of an Object Using Arduino.
4	Connect with the Available Wi-Fi Using Arduino.
5	Sense a Finger When it is Placed on Board Using Arduino.
6	Temperature Notification Using Arduino.
7	LDR to Vary the Light Intensity of LED Using Arduino.
8	MySQL Database Installation in Raspberry Pi.
9	SQL Queries by Fetching Data from Database in Raspberry Pi.
10	Switch Light On and Off Based on the Input of user using Raspberry Pi.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Able to understand the types, working and characteristics of different sensors, actuators and Transducers	CL2

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CO2	Analyze different sensors and Actuators on Arduino-UNO board	CL4
CO3	Analyze different sensors and Actuators on Raspberry-Pi	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	2	3	2				1	1	2	2	2	
CO2	2	2	3	3	2				1	1	3	2	2	
CO3	2	1	2	2	3				1	2	2	2	2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)				

ASSESSMENT STRATEGY

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

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

ASSESSMENT STRATEGY:

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

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

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

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

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

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

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

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

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

SEE QUESTION PAPER PATTERN:

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

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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):

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ANIMATION LAB

(Effective from the Academic Year 2022 - 2023)

IV SEMESTER

Course Code	**RA42297RD**	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.

COURSE OBJECTIVES:

- To skill the students in the Animation concepts.
- To make the students to design and animate the given process.
- To make students simulate the real-time technical environments of the various aspects of industries.
- To design and develop the virtual robotic environment.
- To design and develop the short movies using animation skills.

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	**Inrtroduction to Animation basics and knowledge on** animation softwares such as MAYA, ANIMAKER, BLENDER, ADOBE CHARACTER ANIMATOR
2	Interface,Graphics, navigating in 3D space, and working with basic objects.
3	**Animation Tools:** Insert Edge, Extrude, and Append
4	**Animation Tools:** Bevel & Normals, Booleans, Knob Motion Path, Front, Merge Vertices, Topology
5	**Animation Tools:** Knob Motion Path-Front and back
6	**Animation Tools:** Merge Vertices, Topology, Constraints
7	**Animation of Squirrels** rig for performing a bouncy jump.
8	**Character Animation**-advanced animation shot using a mechanical robot arm
9	**Character Animation**-advanced animation shot using a mechanical robot end effector
10	**Character Animation**- Bouncing Ball, Graph Editor, Finishing Generic Ball Bounce
11	**Character Animation**-Squash and Stretch, Animation Scene Setup, Follow Through Polish
12	**Character Animation**-Walk cycle, walk cycle body, Walk Cycle Polish, Walk Cycle off the spot.

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COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Skill the students in the Animation concepts.	CL4
CO2	Make the students to design and animate the given process.	CL4
CO3	Make students simulate the real-time technical environments of the various aspects of industries.	CL4
CO4	Design and develop the virtual robotic environment.	CL4
CO5	Design and develop the short movies using animation skills.	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	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

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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=CBJp82tlR3M
2. https://www.youtube.com/watch?v=nIoXOplUvAw
3. https://www.youtube.com/watch?v=v3NrfXaJW6c

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BIOLOGY FOR ENGINEERS

(Effective from the Academic Year 2023 - 2024)

IV SEMESTER

Course Code	**BS422T8X**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	2:0:0:0	SEE Marks	50
Total Hours of Pedagogy	30L	Exam Hours	03

CREDITS – 2

COURSE PREREQUISITES:

- Basic Concepts of Biology

COURSE OBJECTIVES:

- Implementation of new technology in medical Science.
- Use modern technical skills to bring out innovations in medical field.

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

Basic Cell Biology- Introduction to Biology, Cell-The unit of life, Cell Theory, Cell structure and Function-Plant cell and Animal cell. **Human Organ System**-Brain as a CPU system - architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Heart as the pump system- Double circulation of human heart, ECG.	**6 Hours**

MODULE - II

Common Diseases and Vaccination - Allergies, Colds and Flu - causes and precautions. First vaccine in the world, Vaccine for Rabies and RNA vaccines for COVID. Heart disease and its types. Modern technologies to detect heart diseases. Engineering solutions for Parkinson's disease. DNA fingerprinting.	**6 Hours**

MODULE - III

Biosensors: Various components of biosensors, Transducers in Biosensors: Various types of transducers; principles and applications, applications of biosensors. **Telemedicine**: Block diagram of telemedicine system, origin and development of Telemedicine, Benefits and limitations of Telemedicine.	**6 Hours**

MODULE - IV

Biomechanics of Joints: Skeletal Joints, Skeletal Muscles, Joint Function, forces and stresses in human joints, Mechanics of the Elbow, Shoulder, Spinal Column, Hip, Knee and Ankle, Applications of prosthetics. **Bio-fluid Mechanics:** Circulatory System in the Human Body, Modeling of Flow in Blood Vessels, Blood Flow Theory. **Biomaterials:** Definition and classification of biomaterials, biocompatibility and biodegradability,	**6 Hours**

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Biomedical Implants.	

MODULE - V

Artificial intelligence for Medical Application: Introduction to Artificial intelligence and machine learning in medical Science. Application of AI in Imaging and Computer-aided Diagnosis, Neuroscience and drug discovery, Genetic algorithms.	**6 Hours**

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Interpret the basics of cell biology and brain functions.	CL2
CO2	Understand effect of common diseases, types of vaccination and general forensics.	CL2
CO3	Summarize the application of biosensors and telemedicine in medical science.	CL2
CO4	Visualize biomechanical joints, biofluid mechanics and bio materials in medical science.	CL2
CO5	Contrast innovative methods of information technology in computer aided medical diagnosis.	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
CO1	1	1	1			1			1	1		1		
CO2	1	1	1			2			1	1		1		
CO3	1	2	2			1			1	1		1		
CO4	1	2	2			2			1	1		1		
CO5	1	2	2			1			1	1		1		

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

ASSESSMENT STRATEGY

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

Sl. No.	Assessment Description	Weightage (%)	Max. Marks
1	**Continuous Internal Assessment (CIA)**	**100 %**	**50**
	Continuous Internal Evaluation (CIE)	60 %	30
	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

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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 TEN full questions.
2. Each full question consists of 20 marks.
3. There will be 2 full questions from all the FIVE modules.
4. Each full question will have a maximum of three sub-questions covering all the topics under a module.
5. The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012
2. Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022.
3. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996.
4. R S Khandpur, “Telemedicine technology and applications”, PHI Learning Pvt. Ltd, New Delhi, 2017.
5. N. Ozkaya and M. Nordin: Fundamentals of Biomechanics-Equilibrium, Motion and Deformation, Springer-Verlag,2nd Edition,1999.

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

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SAHYADRI
COLLEGE OF ENGINEERING & MANAGEMENT
An Autonomous Institution
MANGALURU

UHV-2: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT

(Effective from the Academic Year 2023 - 2024)

SEMESTER - IV

Course Code	**HU42289X**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Exam Hours	03

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**

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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, Programme to ensure self-regulation and Health.	**3 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.	**3 Hours**
MODULE - IV	
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	**3 Hours**
MODULE - V	
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.	**3 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	CL2
CO2	Relate to the needs of self and body to establish co-existence leading to harmony in the human being.	CL2
CO3	Recognize the importance of trust and respect to promote harmony in the family and society.	CL2
CO4	Realize the existence as coexistence to establish harmony through mutual fulfillment among four orders of nature.	CL2
CO5	Recognize the needs for a holistic understanding of human values to develop ethical and professional conduct.	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
CO1								1				2		
CO2						1		1	1					

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CO3						2		1	1			2		
CO4							2	1	1			2		
CO5							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**

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**
CO5			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	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 01 marks.
2. The students have to answer all the questions, selecting one full question from each module

TEXT BOOKS:

1. a. 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:

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).

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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

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HYDRAULIC AND PNEUMATIC SYSTEMS

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code	**ME522I1R**	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 system and their techniques.
- To understand the concept and principle operation 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 Power: Pascal's law, The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, variable displacement pumps. **Hydraulic Actuators and Motors:** Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors and piston motors.	**8 Hours**
MODULE - II	
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, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.	**8 Hours**
MODULE - III	
Hydraulic Circuit Design and Analysis: 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, accumulators and accumulator circuits.	**8 Hours**
MODULE - IV	
Pneumatic Controls: Choice of working medium, characteristics of compressed air, Preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout. Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end position cushioning, seals. Rod – less cylinders – types, working advantages. Rotary cylinder types construction. **Directional Control valves:** Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.	**8 Hours**

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MODULE - V

Multi-cylinder Applications: Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves). **Electro-Pneumatic control:** Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications.	**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	Comprehensive Understanding of Hydraulic Power Systems	CL2
CO2	Proficiency in Hydraulic System Components and Maintenance	CL2
CO3	develop skills in designing and analyzing hydraulic circuits.	CL3
CO4	Understanding of Pneumatic Systems and Components	CL2
CO5	Application of Multi-Cylinder Systems and Electro-Pneumatic Control	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Study of Speed Control Circuit on Hydraulic Trainer	1,2	CL3
2.	Study of Sequencing Circuit on Hydraulic Trainer	1,2	CL3
3.	Study of Synchronizing Circuit on Hydraulic Trainer	1,2,3	CL3
4.	Study of Regenerative Circuit on Hydraulic Trainer	1,2,3	CL3
5.	Study of Counterbalancing Circuit on Hydraulic Trainer	1,2,3	CL3
6.	Study of ISO/GIS Fluid Power Symbols	1,2	CL3
7.	Control of actuators by simple hydraulic circuits	1,2,3	CL3
8.	Control of actuators by simple Pneumatic circuits	4,5	CL3
9.	Create and Demonstration of meter in and meter out circuit.	4,5	CL3
10.	Demonstration of sequencing circuit.	4,5	CL2
11.	Demonstration of pneumatic circuit for speed control of double acting cylinders	4,5	CL2
12.	Demonstration of pneumatic circuit for speed control of pneumatic motor	4,5	CL2

CO-PO-PSO MAPPING

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

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

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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. Fluid Power with applications Anthony Esposito Pearson education, Inc 2000.
2. Pneumatics and Hydraulics Andrew Parr Jaico Publishing Co. 2000.
3. Systems – Principles and Maintenance S. R. Majumdar, Tata McGraw Hill publishing company Ltd. 2001
4. Pneumatic systems S. R. Majumdar Tata McGraw Hill publishing Co 1995.
5. Industrial Hydraulics Pippenger Hicks McGraw Hill, New York. 2001.

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

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

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ROBOT OPERATING SYSTEM 2

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code 21AR52		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 programming, basic robotics concepts, and an understanding of operating system principles.

COURSE OBJECTIVES:

Students will be able to

- 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.	**8 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.	**8 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	**8 Hours**

MODULE - IV

Advanced ROS2 : Using Fast DDS Discovery Server as discovery protocol , Implementing a custom memory allocator, Unlocking the potential of Fast DDS middleware, Recording a bag from a node, Reading from a bag file, Simulators- Gazebo and Webots, Security	**8 Hours**

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MODULE - V

ROS2 Deployment : 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	**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	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.	CL3
CO2	Demonstrate proficiency in using colcon to build packages, creating workspaces and packages, and implementing basic publishers, subscribers, services, and clients, while addressing potential issues with ros2doctor and custom message and service files.	CL3
CO3	Employ advanced ROS2 concepts, such as managing dependencies with rosdep, creating and utilizing actions, composing multiple nodes, monitoring parameter changes, 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, Fast DDS middleware optimization, bag recording and playback, simulators (Gazebo and Webots), and addressing security concerns in robotic applications.	CL4
CO5	Apply QoS settings for lossy networks, manage nodes with lifecycles, establish efficient intra-process communication, leverage rosbag for data recording and playback through the ROS2 bridge, understand real-time programming, experiment with a dummy robot, implement logging, and create content filtering subscriptions using external resources.	CL4

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	ROS2 Installation and Workspace Setup	CO3	CL3
2.	Creating Your First ROS2 Package	CO3	CL4
3.	Writing a Simple Publisher and Subscriber	CO3	CL4
4.	Understanding and creating ROS2 Nodes and RCLCPP/RCLPY	CO3	CL4
5.	Exploring ROS2 CLI Tools	CO3	CL4
6.	Implementing ROS2 Services	CO4	CL4
7.	Using ROS2 Parameters	CO4	CL4
8.	Understanding ROS2 Launch System	CO4	CL4
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	

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CO4	3	3	3						1	1		1		3	
CO5	3	3	3							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
	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. 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

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ROBOT KINEMATICS AND DYNAMICS

(Effective from the Academic Year 2022 - 2023)

SEMESTER - V

Course Code	**RA522T3R**	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 robot configuration, structures, basic components, workspace.
- 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: Introduction, Components of a robotic system, Degrees of Freedom, Classification of robots, position and orientation of objects, objects coordinate frame Rotation matrix, Euler angles Roll, pitch and yaw angles coordinate Transformations, coordinate frames, Rotations, Homogeneous coordinates. Joints, end effectors, grippers.	**8 Hours**

MODULE –II

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.	**8 Hours**

MODULE –III

Inverse Kinematics: The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot.	**8 Hours**

MODULE –IV

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.	**8 Hours**

MODULE –V

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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.	**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	Analyze the relationship between mechanical structures of robots and their operational workspace characteristics.	CL4
CO2	Analyze the forward kinematic analysis of robot manipulators.	CL4
CO3	Analyze the inverse kinematics of simple robot manipulators.	CL4
CO4	Analyze the dynamic analysis of robot manipulators.	CL4
CO5	Analyze the joint trajectory for motion planning.	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					2	2	2		2	2		
CO3	3	3	2					2	2	2		2	2		
CO4	3	3	2					2	2	2		2	2		
CO5	3	3	2					2	2	2		2	2		

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

ASSESSMENT STRATEGY

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

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

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	x			x	X
CO2	x	x		x	X
CO3		x		x	X
CO4			x	x	X
CO5			x	x	X

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.

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ASSIGNMENT TYPES WITH WEIGHTAGES

Sl. No.	Assignment Description	Max. Weightage (%)	Max. Marks
1	Written Assignments	25 %	5
2	Quiz	25 %	5
3	Field Visits/Survey/Case Studies	50 %	10
4	Model / Prototype Development	100 %	20
5	Project Based Learning		
6	Seminar/Presentation	25 %	5
7	Peer - to -Peer Learning	25 %	5

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.
- Each full question consisting of 20 marks.
- There will be 2 full questions from all the FIVE modules.
- Each full question will have a maximum of four sub-questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

REFERENCE BOOKS:

1. Groover M. P, “Industrial Robotics”, Tata McGraw-Hill, 1st Edition, 2013.
2. J. J. Criag, “Introduction to Robotic Mechanics and Control”, Pearson, 3rd Edition, 2013.
3. Richard D. Klafter, “Robotic Engineering”, Prentice Hall, 1st Edition, 2013.
4. Fu K S, “Robotics”, McGraw-Hill, 1st Edition, 2013.
5. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning, 2009.
6. Saha S K, “Introduction to Robotics”, Tata McGraw Hill Education Pvt. Ltd, 2010.

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

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

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DESIGN AND ANALYSIS OF ALGORITHMS

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	**CS522T4R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Mathematics, Data Structures.

COURSE OBJECTIVES:

- Describe the techniques for analyzing algorithms and how to evaluate their performance. Indicate the effectiveness of the method using asymptotic notations.
- Utilize algorithm design techniques including the brute force approach, greedy approach, divide-and-conquer strategy, decrease-and-conquer strategy, transform-and-conquer strategy, dynamic programming, backtracking, and branch-and-bound to solve issues.
- Decide on the best data structure and algorithm design technique for the given application.
- Recognize the fundamental ideas behind NP-complete and NP-hard class issues.

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 Algorithms- Properties, Specification, Fundamentals of Algorithmic Problem solving, Analysis Framework. **Performance Analysis:** Estimating Space complexity and Time complexity of algorithms. Asymptotic Notations with examples, Basic efficiency classes, Mathematical analysis of Non-Recursive and Recursive Algorithms with Examples. **Brute force design techniques:** Selection sort, sequential search and String-matching algorithm with complexity Analysis.	**8 Hours**

MODULE - II

Divide and Conquer: General method, Recurrence equation for divides and conquers, solving it using Master's theorem. , Divide and Conquer algorithms and complexity Analysis of Finding the maximum & minimum, Binary search, Merge sort, Quick sort. **Decrease and Conquer Approach:** Introduction, Insertion sort, Topological Sorting and efficiency analysis.	**8 Hours**

MODULE - III

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Greedy Method: General method, Coin Change Problem, Knapsack Problem, Job sequencing with deadlines, Minimum cost spanning tree algorithms: Prim's Algorithm, Kruskal's Algorithm. **Single source shortest paths:** Dijkstra's Algorithm. **Optimal Tree problems:** Huffman Trees and Codes. **Transform and Conquer Approach:** Heaps and Heap Sort.	**8 Hours**

MODULE - IV

Dynamic Programming: General method with Examples, Multistage Graphs. **Transitive Closure:** Warshall's Algorithm. All Pairs Shortest Paths: Floyd's Algorithm, Knapsack problem, Optimal Binary Search Trees, Travelling Sales Person problem. **Space-Time Tradeoffs:** Sorting by Counting, Input Enhancement in String Matching Harspool's algorithm.	**8 Hours**

MODULE - V

Backtracking: General method, N-Queens problem, Sum of subsets problem, Graph colouring, 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.	**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	Solve the time complexity of recursive, non-recursive and brute force algorithm using asymptotic notations.	CL3
CO2	Solve the recurrence relation to obtain the performance of divide-and-conquer, decrease-and-conquer approach.	CL3
CO3	Demonstrate different algorithms of greedy technique and transform & conquer strategy and analyze its time complexity.	CL3
CO4	Demonstrate dynamic-programming paradigm and String-matching techniques to determine its time complexity.	CL3
CO5	Apply backtracking and branch-and-bound approach on various problems. Categorize algorithms as P, NP, NP-complete and NP-hard classes.	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	
CO2	3	3	2					2				2		3	
CO3	3	3	3					2				2		3	
CO4	3	3	3					2				2		3	
CO5	3	3	3					2				2		3	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

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

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3. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI.
4. Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education).

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

1. https://www.youtube.com/watch?v=gY0MwGLq9W8&list=PLyqSpQzTE6M9DKhN7z2fOpKTJWu-639_P
2. https://www.youtube.com/watch?v=5Y8Lfsreeck&list=PL7DC83C6B3312DF1E
3. https://www.youtube.com/watch?v=S47aSEqm_0I&list=PLgj_V-ZKxRKrxgFyOutPJpoLFBaQMOpK-

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VIRTUAL INSTRUMENTATION LAB

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	**RA522L5R**	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 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
- 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	Basic arithmetic operations
2	Boolean operations
3	Sum of ‘n’ numbers using FOR loop
4	Factorial of a give number using FOR loop
5	Sum of ‘n’ natural numbers using WHILE loop
6	Factorial of a give number using WHILE loop
7	Sorting even numbers using WHILE loop in an array
8	Array maximum and minimum
9	Bundle and unbundle cluster
10	Flat and stacked sequence
11	Application using formula node

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom’s Taxonomy Level
CO1	Able to perform basic arithmetic operations (addition, subtraction, multiplication, division) using programming languages.	CL3
CO2	Demonstrate proficiency in applying boolean operations in programming.	CL3

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CO3	Demonstrate in utilizing FOR and WHILE loops to find the sum of 'n' natural numbers and compute the factorial of a given number.	CL3
CO4	Demonstrate competence in finding the maximum and minimum values in an array.	CL3
CO5	Demonstrate problem-solving skills by solving real-world problems through programming.	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	
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

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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://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

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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code	**CS52216RA**	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 and Prolog.
- 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
- 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 ANN: Biological to Artificial neuron, Training an MLP, Training a DNN with TensorFlow , Fine tuning NN HyperParametersUp and Running with TensorFlow	**8 Hours**
MODULE - II	
Recurrent Neural Network: Recurrent neurons, Basic RNN in Tensor Flow, Convolution Neural Network: Architecture of the visual cortex, Convolutional layer, Pooling layer, CNN architecture	**8 Hours**
MODULE - III	
MACHINE LEARNING Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - Regression: Linear Regression - Logistic Regression	**8 Hours**
MODULE - IV	
SUPERVISED LEARNING Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM)	**8 Hours**
MODULE - V	
UNSUPERVISED LEARNING Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm	**8 Hours**

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Outline the overview of neural network using tensorflow	CL2
CO2	Describe the recurrent neural network and convolutional neural network	CL2
CO3	Describe the machine learning model approaches and concept of bias variance trade off	CL2
CO4	Illustrate supervised learning algorithms in solving classification problem	CL2
CO5	Interpret meaningful patterns from unstructured data and use unsupervised learning algorithms	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	1		
CO2	3	3	2					2				2	1		
CO3	3	3	3					2				2	1		
CO4	3	3	3					2				2	1		
CO5	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

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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. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. Bratko, "Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.
4. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
5. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3rd edition
6. Hands on Machine Learning with Scikit-Learn &TensorFlow, AurelienGeron, O'Reilly, 2019

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

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

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MODEL-BASED SYSTEMS ENGINEERING

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code	**CS52216RB**	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
- 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 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	**8 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.	**8 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.	**8 Hours**
MODULE - IV	
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	**8 Hours**
MODULE - V	
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.	**8 Hours**

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Failure Modes and Effect Analysis (FMEA): Basics of FMEA, Application of FMEA in Model-Based Systems Engineering	

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 processes, methods, and practices of model-based systems engineering	CL2
CO2	Apply model-based systems engineering practices and methods to relevant examples.	CL3
CO3	Understand the architectures, behavior, specifications, verifications, and tests that represent cyber physical systems using model-based systems engineering methods.	CL2
CO4	Understand effective SysML diagrams that accurately represent views of an engineered system.	CL2
CO5	Demonstrate analysis of systems using model-based systems engineering approaches that lead to better and increased performance of systems	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	1				2				2	2	1	
CO2	3	3	2					2				2	2	1	
CO3	3	3	3					2				2	2	1	
CO4	3	3	3					2				2	2	1	
CO5	3	3	3					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**
	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

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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. 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 RequirementsEngineering in Practice. 2009. ISBN: 978-0-07-160547-2

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

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

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EMBEDDED SYSTEMS PROGRAMMING

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code	**CS52216RC**	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.
- Understanding of basic logics of programming

COURSE OBJECTIVES:

- Study the basics of Embedded Systems,History of Embedded Systems, Classification of Embedded Systems.
- Understand about Embedded firmware design and development.
- Study about real time operating systems and its importance.
- To know about Integration and Testing of Embedded Hardware and Firmware.

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 Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Major application areas, Purpose of Embedded Systems, Characteristics and Quality attributes of Embedded Systems.	**8 Hours**
MODULE - II	
The Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System components.	**8 Hours**
MODULE - III	
Embedded Firmware Design and Development: Embedded Firmware Design, Embedded Firmware Development Languages, Programming in Embedded C	**8 Hours**
MODULE - IV	
RTOS Based Embedded System Design: Operating System basics, Types of Operating Systems, Tasks, Process, Threads, Multiprocessing and Multi-tasking, Task Scheduling, Threads-Processes-Scheduling putting them together, Task Communication, Task Synchronization, Device Drivers, How to choose an RTOS	**8 Hours**
MODULE - V	

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Integration and Testing of Embedded Hardware and Firmware: Integration of Hardware and Firmware, Boards Bring up The Embedded System Development Environment: The Integrated Development Environment (IDE), Types of files generated on Cross-Compilation, Disassembler/Decompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.	**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 selection procedure of processors in the embedded domain	CL2
CO2	Understand about typical embedded systems.	CL2
CO3	Design procedure of embedded firmware.	CL3
CO4	Illustrate the role of real time operating systems in embedded systems	CL3
CO5	Evaluate the correlation between task synchronization and latency issues	CL4

CO-PO-PSO MAPPING

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

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		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. Programming Embedded Systems in C and C++, First Edition January, Michael Barr, O' Reilly Introduction to embedded systems, Shibu K V Tata McGraw-Hill.
2. Shibu K V, "Introduction to Embedded Systems", Second Edition, Mc Graw Hill.
3. Embedded Systems, Rajkamal, TataMcGraw-Hill.
4. Frank Vahid and Tony Givargis, "Embedded Systems Design" - A Unified Hardware/Software Introduction, John Wiley.
5. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.

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

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SOFT ROBOTICS

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	**CS52216RD**	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, model, build, and characterize soft robot components (i.e. actuators, sensors, and stiffening components)
- 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
- 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 soft robotics: Definitions and Applications. Morphological computation and Bio inspired design. **Materials for soft robotics**: Elastomers, Thermoplastics and textiles, Advanced materials	**8 Hours**
MODULE - II	
Soft Actuation: Cable driven soft robots, Fluidic actuation, Dielectric elastomers, Shape memory alloys, Additional actuation strategies	**8 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	**8 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.	**8 Hours**
MODULE - V	
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	**8 Hours**

COURSE OUTCOMES

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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 structures.	CL3
CO4	Understand the structural differences between hard and soft robots, the principles of bio-inspiration in soft robotics, and various actuation methods	CL2
CO5	Understand the embedding sensing capabilities and conductive elements in soft structures.	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	
CO5	3	3	3					2				2		2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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

ASSIGNMENT TYPES WITH WEIGHTAGES

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

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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. 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):

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

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RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS
(Effective from the Academic Year 2023- 2024)
SEMESTER – V

Course Code	**RA522E8R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	1:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30L	Exam Hours	03

CREDITS – 2

COURSE PREREQUISITES:

- A foundational understanding of research and knowledge of research problem formulation, familiarity with academic ethics, a basic understanding of statistics and data analysis, ability to search and evaluate academic sources, basic writing and communication skills, critical thinking skills, time management skills and awareness of ethical considerations in research.

COURSE OBJECTIVES:

- Understand the basic concepts, principles, and types of research methodologies
- Collect, analyze, and interpret data using relevant techniques.
- Ethically conduct research and adhere to academic integrity.
- Communicate research findings effectively through written and oral presentations.
- Understand the intellectual property rights and the types of IPR.

TEACHING - LEARNING STRATEGY:

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

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

COURSE CONTENTS

MODULE - I

Introduction to Research Methodology and Literature Review **Introduction to Research Methodology:** Meaning of research, Objectives of research, Types of research, Importance of scientific research in decision making, Defining the research problem, techniques involved in defining a problem**.** Research Design: Meaning of research design, need for research design, Features of good design. **Literature Review:** Significance of literature review, Sources for literature: Books, Journals, Proceedings, Thesis and Dissertations. Online databases: Web of Science, Google and Google Scholar. Quality research papers**.** Research metrics: Citation, Citation Index, Impact Factor, H-index, i10-index, Google index and their significance. ***Text books: 1, 2.***	**6 Hours**

MODULE - II

Data Collection, Analysis and Report Writing **Data Collection:** Introduction, collection of primary data: observation method, questionnaires and case study method, collection of secondary data, Selection of an appropriate method for data collection. **Data Analysis**: Introduction, Data analysis process, Types of data analysis, Methods of data analysis: Qualitative analysis, Quantitative analysis. Tools for data analysis.	**6 Hours**

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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.***	
MODULE - III	
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: 3.***	**6 Hours**
MODULE - IV	
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.***	**6 Hours**
MODULE - V	
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.***	**6 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

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CO3	Understand the research ethics and adhere to ethical norms in the research process.	CL2
CO4	Illustrate the significance of Intellectual property rights and of research projects for economic growth and social benefits.	CL2
CO5	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**	**12**	**1**	**2**
CO1	3	1	1			1		1	1		2			
CO2	3	2	1	1	1	1		1	1		2			
CO3	3	1	1			2		3	1	1	1	2		
CO4	3	2	2	2	1	2		3	1	1	1	2		
CO5	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%**
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 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 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.

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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.

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.

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ENVIRONMENTAL STUDIES

(Effective from the Academic Year 2023 - 2024)

V SEMESTER

Course Code	**BS522D9X**	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: Structure and Function of ecosystems in Forest, Desert, Wetlands, River, Oceanic and Lakes. Sustainability: 17 SDGs- History, targets, implementation, Capacity Development. Success stories - Best practices related to urban ecosystem conservation and sustainable innovations in Mechanical Engineering.	**3 Hours**

MODULE - II

Advances in Energy Systems and Sustainable Practices: Exploration of advanced energy systems: Hydrogen, Solar, OTEC, Tidal, and Wind energy. Evaluation of the merits and demerits of energy systems. Global status and applications of sustainable energy technologies. Case studies in disaster management relevant to mechanical engineering. Sustainable mining practices and their role in responsible resource extraction. Bioenergy - Use of biomass, biogas, and biofuels in the context of renewable energy - their environmental impacts, sustainability, and applications.	**3 Hours**

MODULE - III

Environmental Pollution & Waste Management: Sources, Impacts and Preventive measures of Surface and Ground Water Pollutants, Soil Pollutants, Air pollutants. Waste Management: Solid waste- sources, characteristics health hazards due to exposure & the disposal methods of municipal & Industrial waste, e-waste & biomedical waste.	**4 Hours**

MODULE - IV

Global Environmental Issues & Conservation Global environmental challenges like climate change, acid rain, and ozone depletion. Radon and fluoride concentration in drinking water and their effects on public health. Environmental toxicology - causes and	**3 Hours**

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control measures. Sustainable agriculture practices and green technologies from Mechanical Engineering perspective. Strategies for plastic pollution control and marine conservation.	

MODULE - V

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.	**3 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 Mechanical 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	Extend the issues related to global environment and means for its conservation through sustainable approaches.	CL2
CO5	Categorize the environmental legislation and policies in line with waste management, environmental protection and preservation of biological diversity.	CL2

SEE QUESTION PAPER PATTERN:

- The Question paper will have **FIFTY** multiple choice questions covering the entire five 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.

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TECHNOLOGY ENTREPRENEURSHIP AND BUSINESS ECONOMICS

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**21AR61(A)**	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 help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing and Finance.
- To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.

TEACHING - LEARNING STRATEGY:

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

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

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.	**8 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. Innovation in science, technology and industry: Six Sigma, 5S Techniques.	**8 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.	**8 Hours**

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MODULE - IV

Introduction: Economics, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Time value of money, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems. Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, Equivalent annual worth comparisons, Discussions and problems.	**8 Hours**

MODULE - V

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.	**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	Comprehensive Understanding of Management Principles	CL2
CO2	Develop entrepreneurial competencies by analyzing the role of entrepreneurship in economic development	CL2
CO3	Integrated Marketing and Venture Development Proficiency	CL2
CO4	Application of Economic and Financial Principles	CL3
CO5	Cost Analysis and Depreciation Methods Proficiency	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	3										2			2
CO5	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**

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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. 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

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

https://onlinecourses.nptel.ac.in/noc22_ge03/preview

https://onlinecourses.nptel.ac.in/noc23_ec06/preview

https://archive.nptel.ac.in/courses/110/105/110105067/

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MICROCONTROLLER AND PLC

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA622I2R**	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 basic electronics, programing fundamentals, Boolean algebra and electrical circuits.

COURSE OBJECTIVES:

- Understand the difference between a Microprocessor and a Microcontroller and embedded
- microcontrollers.
- Familiarize the basic architecture of 8051 microcontroller.
- Program 8051microprocessor using Assembly Level Language and C.
- Understand the interrupt system of 8051 and the use of interrupts.
- Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051.
- Interface 8051 to external memory and I/O devices using its I/O ports.
- Understand how PLC works
- Deep understanding of the fundamental principles behind PLCs, including their architecture, operation, and applications.
- To get familiar with the hardware and software components of PLC systems, including input and output modules, CPUs, communication interfaces, and power supplies.

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

8051 Microcontroller: Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture-Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing. ***Text book 1: Chapter 1(Sections 1.2 to 1.6); Chapter-3, Chapter-4,***	**8 Hours**

MODULE - II

8051 Instruction Set: Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.	**8 Hours**

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8051 Stack, I/O Port Interfacing and Programming: 8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status. ***Text book 2: Chapter 1 - 1.1 to 1.4, Chapter 2 - 2.1 to 2.5***	
MODULE - III	
8051 Timers and Serial Port: 8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode2 on a port pin. 8051 Serial Communication-Basics of Serial Data Communication, RS232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially. **8051 Interrupts and Interfacing Applications:** 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, DAC, LCD and Stepper motor and their 8051 Assembly language interfacing programming. ***Text book 1: Chapter 3: Sections 3.1 to 3.6***	**8 Hours**
MODULE - IV	
Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. **PLC Hardware Components:** The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs). **Basics of PLC Programming:** Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation. ***Text book 3: Chapter 1, (Sections 1.1 to 1.6), Chapter 2, (Sections 2.1 to 2.5),***	**8 Hours**
MODULE - V	
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers:** Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers. **Programming Counters:**	**8 Hours**

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Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. ***Text book 3: Chapter-4 (Sections 4.1 to 4.10 only),***	

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 difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051	CL2
CO2	Write 8051 Assembly level programs using 8051 instructions set.	CL3
CO3	Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.	CL3
CO4	Discuss history of PLC and describe the hardware components of PLC: I/O modules, CPU, memory devices, other support devices, operating modes and PLC programming.	CL3
CO5	Describe field devices Relays, Contactors, Motor Starters, Switches, Sensors, Output Control Devices, Seal-In Circuits, and Latching Relays commonly used with I/O module	CL3

LABORATORY COMPONENTS

Exp. No.	Experiment Description	CO No.	Bloom's Taxonomy Level
1.	Data Transfer: Block Move, Exchange, Sorting, Finding largest element in an array.	CO1	CL3
2.	Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bit addressable).	CO1	CL3
3.	Counters.	CO2	CL3
4.	Boolean & Logical Instructions (Bit manipulations).	CO2	CL3
5.	Conditional CALL & RETURN.	CO3	CL3
6.	Programs to generate delay, Programs using serial port and on-Chip timer/counter.	CO3	CL3
7.	Interface a simple toggle switch to 8051 and write an ALP to generate an interrupt which switches on an LED (i) continuously as long as switch is on and (ii) only once for a small time when the switch is turned on.	CO3	CL3
8.	Write a C program to i) transmit and (ii) to receive a set of characters serially by interfacing 8051 to a terminal.	CO3	CL3
9	Write and implement a simple ladder logic program using digital inputs and outputs for PLC.	CO4	CL3
10.	Write and implementation of simple ladder logic program using timer 1) On delay timer 2) Off delay timer 3) Retentive timer	CO5	CL3
11.	Write and implementation of simple ladder logic program using counter. 1) UP counter 2) Down counter	CO5	CL3

CO-PO-PSO MAPPING

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

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2		3							2	1	1	
CO2	3	3	2		3							2	1	1	
CO3	3	3	2		3							2	1	1	
CO4	3	3	2		3							2	1	1	
CO5	3	3	2		3							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
	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. The 8051 Microcontroller Based Embedded Systems, Manish K Patel, McGraw Hill, 2014, ISBN:978-93-329-0125-4.
2. Microcontrollers: Architecture, Programming, Interfacing and System Design, Raj Kamal, Pearson Education, 2005.
3. Programmable Logic Controllers an Engineer's Guide E A Parr Newnes 3rd Edition, 2013
4. Introduction Programmable Logic Controllers Gary Dunning Cengage 3rd Edition, 2006
5. The 8051 Microcontroller and Embedded Systems – using assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
6. The 8051 Microcontroller", Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.

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7. Programmable Logic Controllers Frank D Petruzella McGraw Hill, 4th Edition, 2011

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ROBOT DESIGN AND PROGRAMMING

(Effective from the Academic Year 2022-2023)

SEMESTER - VI

Course Code	**RA622T3R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Mechanics of materials
- Material science
- Basic programing, Python programing.

COURSE OBJECTIVES:

- Define and explain various terms connected to the machine components of robot, like static strength, fatigue strength, Impact stresses, theories of failures, rigidity-based design, factor of safety, and stress concentration etc.
- Explain how engineering design make use of the principles learnt in science courses and identify their practical applications.
- Demonstrate the ability to develop designs for different gears.
- To familiarize fundamental concept of AI and expert system
- To familiarize concept of AI programming languages

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. **Impact Strength:** Introduction, Impact stresses due to axial, bending and torsion loads. Soderberg and Goodman relationships, stresses due to combined loading.	**8 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. **Leaf Springs:** Stresses in leaf springs, equalized stresses, and nipping of leaf springs, Belleville springs. **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.	**8 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.	**8 Hours**

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MODULE - IV	
Introduction to Robot Programming: Methods of Robot Programming Lead through methods - powered lead through, manual lead through, Teach pendant, Robot program as a path in space, defining position in space, motion interpolation, WAIT, SIGNAL and DELAY commands, Branching capabilities and Limitations of head through methods.	**8 Hours**
MODULE - V	
Robot Languages: Textual ROBOT Languages, first generation and second generation languages, structure of a robot language - operating systems, Elements and Functions, constants, variables and other data objects, Motion commands, points in workspace, End effector and sensor commands, computations and operations, program control and subroutines, communications and Data processing.	**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	Determine bending stress, shear stress and design of simple machine components subjected to static loading conditions for different material properties.	CL4
CO2	Analyse the stresses in differernt types of springs and in Wire ropes.	CL4
CO3	Design a pair of spur and Bevel gears and determine the gear parameters critical for the safety of the design.	CL4
CO4	Understand the different methods of Robot Programming.	CL2
CO5	Understand the structure of a robot language.	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
CO1	3	3	3									2	3	
CO2	3	3	3									2	3	
CO3	3	3	3									2	3	
CO4	3	2	1									2		2
CO5	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**
	Continuous Internal Evaluation (CIE)	60 %	30
	Assignments	40 %	20
2	**Semester End Examination (SEE)**	**100 %**	**50**

CO - ASSESSMENT MAPPING

	Continuous Internal Assessment (CIA) (50%)	Semester End Exam (SEE) (50%)

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Course Outcomes	Continuous Internal Evaluation (CIE) (60%)			Assignment/ Activities (40%)	
	I	II	III		
	Syllabus Coverage			Syllabus Coverage	Syllabus Coverage
	40%	30%	30%	100%	100%
CO1	x			x	x
CO2	x	x		x	x
CO3		x		x	x
CO4			x	x	x
CO5			x	x	x

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

ASSIGNMENT TYPES WITH WEIGHTAGES

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

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

SEE QUESTION PAPER PATTERN:

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

TEXT BOOKS:

1. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke, McGraw Hill International edition, 2003
2. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., 2010
3. Machine Design, Robert L., Norton, Pearson Education Asia, 5th Edition, 2013
4. Mikell P, Groover, Mitchell Weiss, Roger N. Nagel and Nicholas G. Odrey, 'Industrial Robotics Technology, Programming and Applications, Mc Graw Hill Book company, 1986

REFERENCE BOOKS:

1. Design of Machine Elements, M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, Pearson Education, 2006
2. Machine Design, Hall, Holowenko, Laughlin, (Schaum"s Outlines series). Tata McGraw Hill Publishing Company Ltd., 2007
3. Bernard Hodges, 'Industrial Robotics', Jaico Publishing House, 1993

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

1. https://nptel.ac.in/courses/112/105/112105124/
2. https://archive.nptel.ac.in/courses/112/101/112101098/

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Convolutional Neural Networks)

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA62214RA**	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 – 4

COURSE PREREQUISITES:

- Fundamental knowledge of Neural Network basics.

COURSE OBJECTIVES:

-

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 Convolutional Neural Networks (CNNs) Overview of Deep Learning and Neural Networks, Basics of Convolution and Convolutional Layers, Activation Functions (ReLU, Sigmoid, Tanh), Pooling Layers (Max-Pooling, Average-Pooling), Fully Connected Layers, CNN Architecture and Components, Training CNNs: Backpropagation and Optimization	**8 Hours**

MODULE - II

CNN Architectures and Variants: LeNet-5: The First CNN, AlexNet: A Breakthrough in ImageNet, VGGNet: Deep Convolutional Networks, GoogLeNet (Inception) Architecture, ResNet: Residual Networks, Transfer Learning and Fine-Tuning, Batch Normalization, Regularization Techniques (Dropout, L2 Regularization), Hyperparameter Tuning for CNNs	**8 Hours**

MODULE - III

Advanced CNN Concepts Object Detection and Localization, Region-based CNNs (R-CNN, Fast R-CNN, Faster R-CNN), YOLO (You Only Look Once) Object Detection, Semantic Segmentation, Instance Segmentation, Data Augmentation for CNNs, Visualizing CNNs (Activation Maps, Filters), Adversarial Attacks and Defense	**8 Hours**

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MODULE - IV	
CNN for Image Classification and Applications Image Preprocessing and Data Loading, Building a CNN from Scratch, Using Pretrained Models, Fine-tuning for Specific Datasets, Evaluation Metrics (Accuracy, Precision, Recall, F1-score), Confusion Matrix and ROC Curves, Cross-validation in CNNs, Deploying CNN Models for Inference, Case Studies: Image Classification Projects	**8 Hours**
MODULE - V	
Advanced CNN Applications and Future Trends CNNs in Medical Image Analysis, Image Style Transfer with CNNs, Face Recognition and Verification, CNNs in Autonomous Vehicles (Self-driving Cars), CNNs in Natural Language Processing (NLP), CNNs in Robotics and Computer Vision, CNNs in Art and Creativity, CNNs in Industry and Business, Future Trends in CNN Research	**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		
CO2		
CO3		
CO4		
CO5		

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														
CO2														
CO3														
CO4														
CO5														

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	

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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.

Text Books:

1. Textbook 1 (T-1): "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
2. Textbook 2 (T-2): "Convolutional Neural Networks" by Janusz Zalewski, Springer, 2018

Reference Books:

1. Reference 1 (R-1): "Python Deep Learning" by Ivan Vasilev and Daniel Slater, Packt Publishing, 2018
2. Reference 2 (R-2): "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron, O'Reilly Media, 2019
3. Reference 3 (R-3): "Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani, Packt Publishing, 2018

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CYBER PHYSICAL SYSTEMS

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	**RA62214RB**	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	
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.	**8 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.	**8 Hours**
MODULE - III	
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	**8 Hours**
MODULE - IV	
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	**8 Hours**
MODULE - V	

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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.	**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 basic principles of design and validation of CPS and CPS HW platforms.	CL2
CO2	Demonstrate the Principles of Automated Control Design and Stability Analysis.	CL3
CO3	Explain the Mapping software components to ECUs and CPS Performance Analysis.	CL2
CO4	Classify the Formal Methods for Safety Assurance of Cyber-Physical Systems.	CL2
CO5	Understand the Hybrid Automata Modelling and Secure Deployment of CPS.	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
CO5	3	3	3					2				2			2

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

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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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

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CLOUD COMPUTING AND FOG COMPUTING

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code	**RA62214RC**	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.	**8 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.	**8 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	**8 Hours**
MODULE - IV	
Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-	**8 Hours**

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time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems	

MODULE - V

Cloud Security, Cloud Application Development: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis .Exercises and problems.	**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	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	Understand the need for resource management and scheduling	CL3
CO5	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		
CO5	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%

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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

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COGNITIVE COMPUTING FOR ROBOTICS AND AUTOMMATION

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	**RA62214RD**	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, python programing.

COURSE OBJECTIVES:

- To understand the main types of cognitive (vision, motor control, language, social skills) robots and their driving requirements (engineering operations, navigation, cooperation)
- To understand advanced methods for creating highly capable cognitive robots
- To dive into the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics
- To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards

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- 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.	**8 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.	**8 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	**8 Hours**
MODULE - IV	
Simultaneous Localization and Mapping (SLAM): Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended	**8 Hours**

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Kalman filter, Graph-Based Optimization Techniques, ParticleMethods Relation of Paradigms.	

MODULE - V

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.	**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 intelligent system design, cognition development, and various facets of intelligence.	CL2
CO2	Understand cognitive development and control principles, and apply a range of nature-inspired methods including artificial neural networks, fuzzy logic	CL3
CO3	Understand appropriate data structures and algorithms, and efficiently plan robot paths in dynamic environments	CL2
CO4	Understand and apply Simultaneous Localization and Mapping (SLAM) techniques, including the mathematical basis.	CL3
CO5	Develop comprehensive programs for autonomous mobile robots, including behaviors like go-to-goal, avoid-obstacles, follow-wall.	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	2		
CO3	3	3	3		2			2				2	2		
CO4	3	3	3		2			2				2	2		
CO5	3	3	3		2			2				2		2	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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	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. HoomanSomani,"Cognitive Robotics", CRC Press, 2015
2. Jared Kroff,"Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016
3. Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", SpringerVerlag Berlin and Heidelberg, 2007
4. David Vernon,"Artificial Cognitive Systems: A Primer" ,The MIT Press, 1st Edition,2014

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

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

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INTRODUCTION TO ROBOTICS

(Effective from the Academic Year 2023 - 2024)

III SEMESTER

Course Code	**RA62225RA**	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
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

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.	**8 Hours**

MODULE - II

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. **3D Homogeneous transformations:** 3D homogeneous rotation Matrix, 3D Homogeneous translation Matrix, Composite rotation Matrix, Rotation Matrix about an Application of 3D homogeneous transformations in robotics, numerical problems.	**8 Hours**

MODULE - III

Sensors used in Robots: 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 for Robots:** Classification - Electric, Hydraulic, Pneumatic actuators, their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, selection of motors; Hydraulic actuators - Components and typical circuit, advantages, and disadvantages; Pneumatic actuators - Components and typical circuit, advantages and disadvantages.	**8 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.	**8 Hours**

MODULE - V

Robot applications: Industrial Applications - Manufacturing, Assembly Automation, Machining, Drilling,	**8 Hours**

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Welding, Painting. Consumer Applications. Emerging Applications - Mobile Robots, Medical Robots, Soft Robots, Collaborative Robots, Cloud Robots, Micro robots, Tele Robots, AGVs, Underwater Robots, Robotics and AI, RPA, Economic and Social Aspects of Robots.	

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 components of robots and their classification.	CL2
CO2	Explain different types of end effectors and 3D homogeneous transformations applied to robotics.	CL2
CO3	Describe the applications of sensors and actuators in robotics.	CL2
CO4	Explain the robot programming techniques.	CL2
CO5	Discuss the diverse applications of robots.	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		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

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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. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, NewDelhi, 2003.
2. Mikell. P. Groover, “Industrial Robotics Technology”, Programming and Applications, McGraw Hill Co, 1995.
3. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education, 2014.
4. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2019.

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

1. https://nptel.ac.in/courses/112105249

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INTRODUCTION TO AUTOMATION

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA62225RB**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Manufacturing Operations, Basics of Computers.

COURSE OBJECTIVES:

- To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
- To make students understand the applications of the Automated flow lines in different processes of industries.
- To expose students to the various characteristic features of PLC and PLC programming basics.
- To expose students to understand the various aspects of ladder programming and its blocks.
- To expose the students to concepts of SCADA and its 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
- 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 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.	**8 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.	**8 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.	**8 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	**8 Hours**
MODULE - V	
Introduction to SCADA Introduction and SCADA Basics. Importance of SCADA in Industrial Automation, Basic operation of SCADA-Basic window property concepts of SCADA	**8 Hours**

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COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.	CL2
CO2	To make students understand the applications of the Automated flow lines in different processes of industries.	CL2
CO3	To expose students to the various characteristic features of PLC and PLC programming basics.	CL2
CO4	To expose students to understand the various aspects of ladder programming and its blocks.	CL2
CO5	To expose the students to concepts of SCADA and its characteristics.	CL2

CO-PO-PSO MAPPING

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

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

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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2	Quiz	10 %	02
3	Case Studies	25 %	05
4	Seminar/Presentation	15 %	03
5	Peer - to - Peer Learning	10 %	02
6	Activity Based Learning	50 %	10
7	Project Based Learning	50 %	10
8	Field Work + Report	50 %	10
9	Industry Visit + Report	50 %	10
10	NPTEL/MOOC Courses – Registration and Assignment Submissions	50 %	10
	NPTEL Certification	75 %	15
11	Any other Innovative Assignments (CL4 and above)	50 %	10

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

SEE QUESTION PAPER PATTERN:

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

REFERENCE BOOKS:

1. Automation, Production Systems and Computer-Integrated Manufacturing, Mikell P Groover, Pearson Learning, 4th edition, 2015
2. CAD / CAM Principles and Applications, P N Rao, Tata McGraw-Hill, 3rd Edition 2015
3. CAD / CAM Principles and Applications, P N Rao, Tata McGraw-Hill, 3rd Edition
4. Principles of Computer Integrated Manufacturing, S Kant Vajapayee, Prentice Hall of India, 1999

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

1. **https://www.youtube.com/watch?v=49RET0NITY&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS**
2. **https://www.youtube.com/watch?v=eFU7tSld7Yc&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS&index=2**

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Introduction to CPS

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	**RA62225RC**	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	
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.	**8 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.	**8 Hours**
MODULE - III	
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	**8 Hours**
MODULE - IV	
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	**8 Hours**
MODULE - V	

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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.	**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 basic principles of design and validation of CPS and CPS HW platforms.	CL2
CO2	Demonstrate the Principles of Automated Control Design and Stability Analysis.	CL3
CO3	Explain the Mapping software components to ECUs and CPS Performance Analysis.	CL2
CO4	Classify the Formal Methods for Safety Assurance of Cyber-Physical Systems.	CL2
CO5	Understand the Hybrid Automata Modelling and Secure Deployment of CPS.	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
CO5	3	3	3					2				2			2

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

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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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

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INTRODUCTION TO ROBOT OPERATING SYSTEMS

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA62225RD**	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:

Students will be able

- Discuss the fundamental concepts of Operating Systems.
- Explain the mechanisms of Operating Systems to handle processes, threads and their communication.
- Analyze the file structure and the protection and security mechanism.
- Explain the Memory management technique to improve the CPU utilization and its response speed.

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 Operating Systems: Basic Principles, Operating System Structures, System Calls & Types, Processes: Concept – Scheduling – Inter Process Communication, Introduction to Distributed Operating System, Types of network-based OS.	**8 Hours**
MODULE - II	
Overview of RTOS: RTOS Task and Task State, Preemptive Scheduler, Process Synchronization, Message Queues, Mailboxes, Pipes, Critical Section, Semaphores, Classical Synchronization Problem –Deadlocks.	**8 Hours**
MODULE - III	
Board Support Packages: Inserting BSP in Kernel Build Procedure, Boot loader Interface, Memory Map, Interrupt Management, PCI Subsystem: Timers - UART- Power Management. Embedded Storage: MTD – MTD Architecture - MTD Driver for NOR Flash - Flash Mapping Driver.	**8 Hours**
MODULE - IV	
Embedded Kernel & Components: Embedded File System: RAM Disk – RAMFS – CRAMFS, Journaling Flash File Systems: JFFS and JFSS2, NFS: PROC File system, Optimizing storage Space: Kernel space optimization - Application Space Optimization, Applications for Embedded Linux - Tuning kernel memory.	**8 Hours**
MODULE - V	

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Linux Devices Drivers: Embedded Drivers: Linux Serial Driver - Ethernet Driver - I 2C Subsystem on Linux - USB Gadgets, Watchdog Timer, Kernel Modules.	**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	Possess a foundational understanding of OS principles, structures, processes, system calls, and be equipped with knowledge on distributed and network-based OS types.	CL3
CO2	Perform concepts of RTOS tasks, scheduling, synchronization techniques, communication mechanisms, and deadlock challenges in real-time operating systems.	CL3
CO3	Integrate BSPs into kernel builds, understand boot loader interfaces and system components, and effectively engage with embedded storage systems and associated drivers.	CL3
CO4	Managing embedded file systems, optimizing kernel and application spaces, and fine-tuning kernel memory for enhanced embedded Linux applications.	CL3
CO5	Understand the Linux device drivers, with a focus on embedded drivers including serial, Ethernet, I2C, USB gadgets, watchdog timers, and kernel modules.	CL3

CO-PO-PSO MAPPING

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

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

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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

ASSIGNMENT TYPES WITH WEIGHTAGES

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

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

SEE QUESTION PAPER PATTERN:

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

TEXT BOOKS:

1. Silberschatz, Galvin, Gagne, "Operating System Concepts", 6th edition, John Wiley, 2003.
2. Raj Kamal, "Embedded Systems -Architecture, Programming and Design", Tata McGraw Hill, 2006.
3. P. Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and development", Auerbach Publications 2005.
4. Jonathan Corbet, Allesandro Rubini &Greg Kroah-Hartman, "Linux Device Drivers", O'Reilly, 3rdedition, 2005.

REFERENCE BOOKS:

1. Programming Robots with ROS: A Practical Introduction to the Robot Operating System by Morgan Quigley, Brian Gerkey, and William D. Smart.
2. Mastering ROS for Robotics Programming by Lentin Joseph.
3. Learning Robotics using Python: Design, simulate, program, and prototype an autonomous mobile robot using ROS, OpenCV, PCL, and Python, 3rd Edition by Lentin Joseph

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

1. https://www.youtube.com/watch?v=PEzpOembKNc
2. https://www.youtube.com/watch?v=mCs21yByQqk
3. https://www.youtube.com/watch?v=hDn4hM148V8

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ROBOT PROGRAMMING LABORATORY

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA622L7R**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	20P	Exam Hours	03

CREDITS – 1

COURSE PREREQUISITES:

- Knowledge of RAPID Programming**.**

COURSE OBJECTIVES:

- Understand the features of DOBOT Magician and DOBOT Studio Software.
- Understand the concept of RAPID Programming.
- Understand the hardware configuration and abilities of ABB IRB 1600 Robot.
- Understand the features of COGNIX camera and its application

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	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: Rapid Procedure, Modules, Data with Multiple Values: Arrays, Composite Data types.
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

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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.
12	Demonstration of RAPID programming in teach pendant and execution of the same using ABB robot.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Analyse different Operations using DOBOT magician.	CL4
CO2	Understand the Programming concepts.	CL2
CO3	Analyse the RAPID Programming Structure.	CL4
CO4	Analyse the different operation of an object in Robot Studio Software.	CL4
CO5	Understand the features of COGNEX Camera, configuration and abilities of ABB IRB 1600 Robot.	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
CO1	3	2	3		2							1		
CO2	3	2	3		2							1		
CO3	3	2	3		2							1		
CO4	3	2	3		2							1		
CO5	3	2	3		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 (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

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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):

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ML Using Scikit, Pytorch and Tensorflow

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA62298RA**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	02

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

Design, develop, and implement the specified algorithms using Google Collab under LINUX/Windows environment.

Exp. No.	Description	COs	CSL
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.	CO1	CL4
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.	CO1	CL4
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.	CO2	CL4
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.	CO2	CL4
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.	CO3	CL4
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.	CO3	CL4

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7	Decision Trees with Scikit-Learn: Build and visualize decision trees for classification or regression tasks. Understand tree parameters and how to prevent overfitting.	CO3	CL4
8	Autoencoders with TensorFlow: Create an autoencoder for dimensionality reduction or denoising on image datasets. Explore the architecture of autoencoders and their applications.	CO4	CL4
9	PyTorch Custom Dataset and DataLoader: Learn to create a custom dataset class in PyTorch. Implement a DataLoader for efficient data handling and batching during training.	CO5	CL6
10	Hyperparameter Tuning with Scikit-Learn: Use Scikit-Learn's Grid Search CV or Randomized Search CV to perform hyperparameter tuning on a machine learning model. Analyze the impact of different hyperparameters on model performance.	CO5	CL6

Note: Installation procedure of the required software must be demonstrated, carried out in groups and documented in the journal.

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.	CL6

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**

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

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PLM Lab

(Effective from the Academic Year 2023 - 2024)

VI SEMESTER

Course Code	**RA62298RB**	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.

COURSE OBJECTIVES:

- Demonstrate prerequisites of PLM
- Make able to understand implementation procedures of PLM tools.
- Build confidence in using CAD /CAE software along with PLM 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

LIST OF EXPERIMENTS

Sl. No.	Description
1	Introduction to PLM lab, Installation of Various softwares Oracle / SQL Server / DB2, PLM Server,CAD Software, MS Office, Rich client, Web client, Application server, Software/ Hardware/ Network issues resolutions
2	CAD: Modeling (at least 5 parts) and Assembly using any High End CAD Softwar Assembly should include top down and bottom-up approaches, Drafting (at least 1 assembly)
3	CAD File/data exchange amongst the various CAD software and software for CMM, CAE, CNC, CAM
4	FEA: Analysis (structural, thermal and both) of at least two parts, Introduction to nonlinear analysis
5	PLM: Exhibiting use of following modules of any PLM software through at least six assignments Organization • Workflow • Product Structure • Access Manager • Query Builder • Change Management • Schedule Manager • Manufacturing Process Planner

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COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Graduate can demonstrate practical uses of various PLM technologies.	CL2
CO2	Configure the various CAD/CAE and PLM tools.	CL2
CO3	Build the various CAD/CAE models to use in PLM applications.	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		3	2		
CO2	3	2	3		2					2		3	2		
CO3	3	2	3		2					2		3	2		
CO4	3	2	3		2					2		3	2		
CO5	3	2	3		2					2		3	2		
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

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

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

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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.AUTOSAR.org/standards/
2. https://www.comasso.org/
3. AUTOSAR Architecture (Learn from Scratch with Demo) - https://www.udemy.com/course/AUTOSAR-architecture/

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SoC Lab

(Effective from the Academic Year 2024 - 2025)

VI SEMESTER

Course Code	**RA62298RC**	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:

- Working knowledge of C and C++, including software development and debugging (e.g., EE322C Data Structures, or equivalent);
- Embedded real-time system design and hardware/software interfacing (e.g., EE445M Embedded & Real-Time Operating Systems, or equivalent);
- Digital hardware design and hardware description languages (e.g., EE460M Digital System Design using Verilog, or equivalent);
- It is helpful to have some basic knowledge of linear algebra and machine/deep learning algorithms.

COURSE OBJECTIVES:

- Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.
- Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.
- Analyze tradeoffs and explore architecture and mico-architecture design spaces to develop and synthesize custom hardware accelerators
- Understand hardware, software, and interface synthesis.
- Understand issues in interface design.
- Use co-simulation to validate system functionality.
- Describe examples of applications and systems developed using a co-design approach.
- Appreciate issues in system-on-chip design associated with co-design, such as intellectual property, reuse, and verification.

TEACHING - LEARNING STRATEGY:

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

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

LIST OF EXPERIMENTS

Sl. No.	Description
1	**Introduction to FPGA and SoC Platforms:** Blink an LED using both FPGA logic and embedded processor.
2	**HDL Design and Simulation:** Design, simulate, and implement basic digital circuits, such as adders or multiplexers.
3	**Embedded Software Development:** Write, compile, and run a simple program on the embedded processor.
4	**Interfacing External Memory:** Read/write operations to the memory and performance evaluation.

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5	**Designing Custom IP Cores:** Design a simple custom peripheral (like a PWM controller), integrate it into the SoC, and control it via software.
6	**Communication Protocols:** Implement and test protocols like UART, SPI, I2C, etc., and establish communication between the SoC and an external device.
7	**RTOS on SoC:** Deploy an RTOS (like FreeRTOS) on the embedded processor and develop multitasking applications.
8	**Power and Performance Optimization:** Measure power consumption under different workloads and implement power-saving techniques.
9	**Hardware/Software Co-design:** Develop a system where a specific task is partitioned between the FPGA logic and the embedded processor.
10	**Advanced Project - Complete SoC System Design:** Design and implement an SoC-based project, such as a simple IoT device, a media player, or a robot controller.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Design and manipulate FPGA and SoC platforms, as well as simulate and implement foundational digital circuits using HDL	CL2
CO2	Develop embedded software and effectively interfacing with external memory systems.	CL2
CO3	Design custom IP cores and understand the intricacies of various communication protocols	CL2
CO4	Implement RTOS on SoC platforms and master techniques for power and performance optimization.	CL2
CO5	Perform hardware/software co-design and undertake advanced SoC system design projects from concept to completion.	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	3							1		1		2	
CO2	3	3	3							1		1		2	
CO3	3	3	3							1		1		2	
CO4	3	3	3							1		1		2	
CO5	3	3	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**
	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

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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. P. Marwedel, Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, Third Edition, Springer, 2018. (author's website)
2. D. C. Black, J. Donovan, B. Bunton, A. Keist, SystemC: From the Ground Up, Second Edition, Springer, 2010.
3. G. De Micheli, Synthesis and Optimization of Digital Circuits, McGraw-Hill, 1994.

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VR App Development

(Effective from the Academic Year 2022 - 2023)

VI SEMESTER

Course Code	**RA62298RD**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	24P	Exam Hours	02

CREDITS – 1

COURSE PREREQUISITES:

- Basic 3D Modeling Skills with software like Blender or other 3D modeling tools.
- Programming concepts, especially in languages commonly used in game development and VR, such as C# or JavaScript, can be advantageous (but not essential).

COURSE OBJECTIVES:

- To proficiently use Blender, including installation, interface navigation, and basic 3D modeling techniques, setting a strong foundation for virtual reality (VR) app development.
- To gain expertise in applying textures, materials, shaders, and reflections to 3D objects, enhancing their ability to create visually compelling VR environments.
- To acquire the skills needed to model VR objects, compose VR scenes, apply lighting and shading, and implement interactions, ultimately culminating in the creation of a complete VR app using both Blender and Unity.

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	COs	CSL
1	Blender Basics- Install Blender and get familiar with its interface. Create basic 3D shapes, manipulate them, and navigate the 3D viewport.	CO1	CL4
2	Texturing and Materials-Learn how to apply textures to objects. Experiment with basic materials, shaders, and reflections	CO1	CL4
3	Modeling VR Objects - Model simple VR objects like a table and a chair. Ensure proper scale and proportions for VR.	CO2	CL4
4	UV Mapping and Unwrapping - Understand UV mapping and unwrap objects. Apply textures to objects using UV mapping.	CO2	CL4

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5	Scene Composition - Create a VR room with the modelled objects. Arrange the scene and set up a camera for VR viewing.	CO3	CL4
6	Lighting and Shading - Add lighting sources to the scene for realism. Experiment with different lighting setups and shading options.	CO3	CL4
7	Adding Interaction - Learn about Blender's built-in game engine for interactions. Implement basic interactions like object picking and dropping.	CO3	CL4
8	Simple Animations - Create animations for objects in the VR environment. Animate object movement, rotation, and scaling.	CO4	CL4
9	Exporting to Web VR - Learn about exporting to Web VR formats using platforms like A-Frame. Convert your Blender scene into a Web VR experience.	CO5	CL4
10	Exporting to Unity - Export your Blender assets to Unity for further VR development. Set up the VR environment and import your assets.	CO5	CL6
11	VR Interaction in Unity - Implement VR interactions using Unity's VR toolkit. Add gaze-based interaction and simple VR interactions.	CO5	CL6
12	Captstone VR App Project - Combine all your skills to create a simple VR app. Develop a VR environment with interactive objects and animations	CO5	CL6

Note: Installation procedure of the required software must be demonstrated, carried out in groups and documented in the journal.

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Apply Blender and Unity for VR app development, as evidenced by their ability to navigate the software interfaces, model objects, apply textures, and implement VR interactions.	CL4
CO2	Create 3D models of VR objects with correct scale and proportions, with the skills to compose immersive VR scenes, including setting up cameras and lighting for realistic experiences.	CL4
CO3	Apply and create texture mapping, UV unwrapping, and material application techniques, enabling them to enhance the visual appeal and realism of VR environments.	CL4
CO4	Create interactive elements within VR environments using both Blender's built-in game engine and Unity's VR toolkit. They will be proficient in creating interactions such as object picking, dropping, and gaze-based interaction.	CL4
CO5	Create VR App by export asseting from Blender to Unity, integrate them into a VR environment, and create a complete VR app. This culminating outcome will showcase their skills in developing VR experiences from concept to execution.	CL6

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

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CO1	3	3	3		3			2	2	1		2	2	2
CO2	3	3	3		3			2	2	1		2	2	2
CO3	3	3	3		3			2	2	1		2	2	2
CO4	3	3	3		3			2	2	1		2	2	2
CO5	3	3	3		3			2	2	1		2	2	2
3: Substantial (High)					**2: Moderate (Medium)**					**1: Poor (Low)**				

ASSESSMENT STRATEGY

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

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

ASSESSMENT STRATEGY:

I. In Laboratory Courses where (B) and (C) are not the components of the assessment pattern, then (A) will have 100% weightage (50 Marks).
Assessment Mode: Weekly Assessment of Laboratory Work (50 Marks) - the marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment, each of 25 marks) of the students in each laboratory session. The average of all the marks obtained across the sessions will be the Final CIA marks.

II. In Laboratory Courses where (C) is not a component of the assessment pattern, then (A) will have 50% weightage (25 Marks), and (B) will have 50% weightage (25 Marks).
Assessment Mode: The marks will be awarded based on the Continuous Internal Assessment (Weekly Assessment) (A) and One Laboratory Test (B).
- In Weekly Assessment, the student will be evaluated in each laboratory session for 25 marks. The average marks obtained across all the experiments will be the marks obtained for (A).
- A Laboratory Test, similar to the SEE exam is conducted towards the end of the Semester/Course, whichever is earlier. The obtained marks are scaled down to 25 Marks (B)

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

III. In Laboratory Courses where (C) is a component of the assessment pattern, then assessment will be done by considering the weightages given above, i.e. (A) – 25 Marks (Weekly Assessment), (B) – 15 Marks (Laboratory Examination), (C) – 10 marks (Open Ended Experiments/Mini Projects)
- The respective course instructor will design the assessment criteria for the said assessment components.
- The assessment components will be made known to the students by the respective Course Coordinators prior to the commencement of the Laboratory Work.

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

SEE QUESTION PAPER PATTERN:

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

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

1. https://www.blender.org/support/tutorials/

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2. https://learn.unity.com/

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INDUSTRIAL INTERNET OF THINGS

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA722I1R**	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
- At the end of the program, students will be able to understand how to develop and implement their 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 What is IIoT and connected world? the 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):** What is sensor? Types of sensors, working principle of basic Sensors -Ultrasonic Sensor, IR sensor, Temperature and Humidity Sensors (DHT-11).Digital switch, Electro Mechanical switches.	**8 Hours**

MODULE - II

Communication Technologies of IIoT 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.	**8 Hours**

MODULE - III

Visualization and Data Types of IIoT	**8 Hours**

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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.	

MODULE - IV

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).	**8 Hours**

MODULE - V

Control & Supervisory Level of Automation Programmable logic controller (PLC), Real-time control system, Supervisory Control & Data Acquisition (SCADA). HMI in an automation process, ERP & MES. **Application of IIOT** **Case study:** Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.	**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	Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security	CL2
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 technological developments that will likely shape the industrial landscape in the future	CL3
CO5	Understand how to develop and implement own IoT technologies, solutions, and applications	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

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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
CO5	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
		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. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)

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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)

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INDUSTRIAL AUTOMATION

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA722T2R**	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:

- Computer Aided Manufacturing Concepts

COURSE OBJECTIVES:

- To impart the knowledge of industrial process control philosophies.
- To expose students to the various characteristic features of PLC and PLC programming basics.
- To expose students to understand the various aspects of ladder programming and its blocks and functions.
- To expose the students to concepts of PLC data handling.
- To make students understand the use of PLC elements in controlling electrical and electronic circuits.

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

Nature of Industrial Process: Continuous & discrete state sequential process, process variables and their classification. Introduction to Process Control Philosophies: type of relays, ladder logic methodology, ladder symbols.	**8 Hours**

MODULE - II

Introduction to Programmable Logic Controllers: Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, and memory structure of PLC. **PLC programming methodologies:** ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC.	**8 Hours**

MODULE - III

PLC functions: Bit logic instructions, ladder diagram examples, interlocking, latching, interdependency and logical functions, PLC Timer & Counter functions on-delay timer, off-delay timers, retentive on-delay timers, pulse timers, timer examples, up-counter, down-counter and up-down counter, counter-examples, register basics.	**8 Hours**

MODULE - IV

PLC Data Handling: Data move instructions, table and register moves, PLC FIFO & LIFO functions. PLC arithmetic and logical functions: addition, subtraction, multiplication, division instructions, increment decrement, trigonometric and log functions, AND, OR, XOR, NOT functions, PLC compare and convert functions.	**8 Hours**

MODULE - V

PLC program control and interrupts: Jumps, subroutine, sequence control relay, watchdog Analog value processing: types of analog modules, analog input and output examples, PID control of continuous process.	**8 Hours**

COURSE OUTCOMES

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

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CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Impart the knowledge of industrial process control philosophies.	CL2
CO2	Expose students to the various characteristic features of PLC and PLC programming basics.	CL2
CO3	Expose students to understand the various aspects of ladder programming and its blocks and functions.	CL2
CO4	Expose the students to concepts of PLC data handling.	CL2
CO5	Make students understand the use of PLC elements in controlling electrical and electronic circuits.	CL2

CO-PO-PSO MAPPING

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

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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

ASSIGNMENT TYPES WITH WEIGHTAGES

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

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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. JOHN WEBB: Programmable Logic Controllers Principles & applications, PHI
2. T. A. HUGHES: Programmable Controllers
3. C. D. JOHNSON: Process Control Instrumentation

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

1. **https://www.youtube.com/watch?v=49RET0NITY&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS**
2. **https://www.youtube.com/watch?v=eFU7tSld7Yc&list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS&index=2**

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Reinforcement learning for Robotics & Automation

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA72213RA**	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.

COURSE OBJECTIVES:

- Reinforcement learning offers to robotics a framework and set of tools for the design of sophisticated and hard-to-engineer behaviors. Conversely, the challenges of robotic problems provide both inspiration, impact, and validation for developments in reinforcement learning. The relationship between disciplines has sufficient promise to be likened to that between physics and mathematics.

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 Introduction to Reinforcement learning for Robotics and Automation, How is Reinforcement learning is different from supervised learning, Charecteristics of Reinforcement learning, Reinforcement learning algorithms, Types of Reinforcement learning, Widely used Reinforcement learning models, Prctical applications of Reinforcement learning	**8 Hours**

MODULE - II

Natural Language Processing Common Natural Language Processing (NLP) Task, Working of Natural Language Processing, Natural Language Understanding (NLU), Natural Language Generation (NLG), Technologies related to Natural Language Processing,Applications of Natural Language Processing, Future scope - Bots, Supporting Invisible UI, Smarter search.	**8 Hours**

MODULE - III

Open AI & Unity ML Tools Introduction to Open AI, Generative Pre-trained Transformer 2 & 3,OpenAI Codex Open AI API, DALL-E, OpenAI Gym, Applications of Open AI. Introduction to Machine learning, Building a genetic algorithm,Use of Proximal Policy Optimisation to train a neural network. Different types of ML tools and their applications.	**8 Hours**

MODULE - IV

Deep Learning	**8 Hours**

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Introduction to deep learning, perceptron,Atificial neural network, Recurrent neural network,Restricted Boltzmann machine, Auto encoders, Convolutional neural networks, Deep learning Algorithms, Deep learninf Framework, Applications of deep learning.	

MODULE - V

Tensarflow and Keras Introduction to Tensorflow and Keras, preliminary Tensarflow and Keras applications,Unsuperwised learning with Tensorflow and Keras,Multi Layer Perceptron,Keras MLP for Binary Classification,Keras MLP for Multiclass Classification, Deep Neural Network (DNN) Classifier with Tensorflow, Deep Neural Network (DNN), Applications of Tensarflow and Kesar in Robotics and Automation field.	**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 basics of Reinforced learning.	CL2
CO2	Study the working and future scope of Natural Language processing.	CL2
CO3	Explore the applications of Open AI and Unity ML tools.	CL2
CO4	Understand the basics of Deep learning	CL2
CO5	Study the applications and classification of Tensarflow and Keras.	CL2

CO-PO-PSO MAPPING

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

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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. Reinforcement Learning and Stochastic Optimization by Warren B Powell , John Wiley & Sons.
2. Reinforcement Learning and Optimal Control Book by Dimitri Bertsekas.
3. Reinforcement Learning: An Introduction , Book by Andrew Barto and Richard S. Sutton
4. Algorithms Reinforcements learning by Csaba Szepesvari

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

1. https://www.youtube.com/watch?v=JgvyzIkgxF0
2. https://www.youtube.com/watch?v=FgzM3zpZ55o

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PRINCIPLES OF INDUSTRY 5.0

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA72213RB**	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
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I

INDUSTRY 5.0 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	**8 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.	**8 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	**8 Hours**

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Management., Intellectual Property Rights- Case Studies - Milk Processing and Packaging Industries	

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 applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Intellectual Property Rights (IPR).	**8 Hours**

MODULE - V

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. Case Studies- Development of AR/VR Models in Unity.	**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	Identify the digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth	CL2
CO2	Analyze enhanced new production models in electronics	CL2
CO3	Implement various electronics manufacturing technologies of augmented reality beyond automation and optimization	CL2
CO4	Evaluate the performance of various cyber physical systems	CL2
CO5	Understand the use of AR and VR in Industry 5.0.	CL2

CO-PO-PSO MAPPING

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

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	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. 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)

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

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Mechanical Engineering & Allied Program

BIG DATA ANALYTICS

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA72213RC**	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:

- This course gives an overview of Big Data, i.e. storage, retrieval and processing of big data. In addition, it also focuses on the "technologies", i.e., the tools/algorithms that are available for storage, processing of Big Data. It also helps a student to perform a variety of "analytics" on different data sets and to arrive at positive conclusions.

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 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.	**8 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.	**8 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.	**8 Hours**

MODULE - IV

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MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.	**8 Hours**

MODULE - V

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:	**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 fundamentals of Big Data analytics.	CL2
CO2	Investigate Hadoop framework and Hadoop Distributed File system.	CL3
CO3	Illustrate the concepts of NoSQL using MongoDB and Cassandra for Big Data.	CL3
CO4	Demonstrate the MapReduce programming model to process the big data along with Hadoop tools.	CL2
CO5	Use Machine Learning algorithms for real world big data.	CL2

CO-PO-PSO MAPPING

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

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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. 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):

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

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MEDICAL ROBOTICS

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	**RA72213RD**	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:

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.
- Be familiar with the state of the art in applied medical robotics and medical robotics research.
- Understand the various roles that robotics can play in healthcare.

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 medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – Stateof art of robotics in the field of healthcare-DICOM.	**8 Hours**

MODULE - II

LOCALIZATION AND TRACKING: Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.	**8 Hours**

MODULE - III

DESIGN OF MEDICAL ROBOTS: Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.	**8 Hours**

MODULE - IV

SURGICAL ROBOTICS: Minimally invasive surgery and robotic integration - surgical robotic sub systems - synergistic control - Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery - case studies	**8 Hours**

MODULE - V

REHABILITATION AND MEDICAL CARE: Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots - Robots in Physiotherapy - case studies	**8 Hours**

COURSE OUTCOMES

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

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CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Identify various medical robots and their potential applications.	CL2
CO2	Recognize the position tracking and hybrid systems.	CL3
CO3	Design a medical robotic system given the specific requirements for Rehabilitation and Medical care.	CL2
CO4	Simulate a MIS procedure and be aware of the state of art in surgical and oncology robotics.	CL2
CO5	Apply Robotics and its concepts in medical field.	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
CO1	3	2	1	1								1		2
CO2	3	2	1	1								1		2
CO3	3	2	1	1								1		2
CO4	3	2	1	1								1		2
CO5	3	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
		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

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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. Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016.
2. Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2013.
3. Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, "The
4. Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2019.
5. Jocelyne Troccaz , "Medical Robotics", John Wiley & Sons Incorporated, 2013.
6. Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
7. Farid Gharagozloo "Robotic Surgery", Springer, 2022.

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

1. https://coursesity.com/course-detail/medtech-ai-and-medical-robots-course-futurelearn

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Mechanical Engineering & Allied Program

INTRODUCTION TO ROBOT PROGRAMMING

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA72224RA**	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.	**8 Hours**
MODULE - II	
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.	**8 Hours**
MODULE - III	
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.	**8 Hours**
MODULE - IV	
AML Language: General description, elements and functions, statements, constants and variables, program control statements, operating systems, motion, sensor commands, data processing.	**8 Hours**
MODULE - V	
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.	**8 Hours**

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COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Discuss the introduction to robot programming.	CL2
CO2	Summarize the programming concepts of VAL I and VAL II language.	CL2
CO3	Discuss the programming concepts of Rapid language.	CL2
CO4	Describe the programming concepts of AML language.	CL2
CO5	Summarize the application of virtual robot.	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		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

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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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INTRODUCTION TO PLC & SCADA

(Effective from the Academic Year 2022 - 2023)

V SEMESTER

Course Code	**RA72224RB**	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
- 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 PLC: Need and tools of automation, Evolution of PLC, Architecture PLC Block Diagram and working, selection of PLC, Types of PLCs, Advantage, limitations and applications of PLCs, Networking of PLCs.	**8 Hours**
MODULE - II	
PLC Hardware: Input and output modules of PLC-working, description, wiring details, specifications, interfacing instruction set for given operation, Ladder programming, Ladder logins for some applications.	**8 Hours**
MODULE - III	
PLC Programming and Applications: Programming languages for PLCS, PLC programming standard IEC61131, relay type instructions- timer, counter, arithmetic operation, data handling instructions. PLC based applications as motor control, traffic light.	**8 Hours**
MODULE - IV	
Introduction to SCADA: Application area of SCADA: Architecture -elements, block diagram of SCADA, Types of SCADA, MTU, RTU Functions, communications in SCADA, Applications of SCADA.	**8 Hours**
MODULE - V	
SCADA interfacing and applications: Interfacing of SCADA with PLC, creating SCADA display, applications of SCADA for ON-OFF lamp, Traffic light control, water level control, motor control.	**8 Hours**

COURSE OUTCOMES

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

CO No.	Course Outcome Description	Bloom's Taxonomy Level
CO1	Understand the basic requirements of a PLC input/output devices and architecture.	CL2
CO2	Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.	CL3
CO3	Ability to design PLC programs by applying timer/counter and arithmetic and logic instructions studied for ladder logic and function block.	CL3
CO4	Apply the concepts of Communication used for PLC/SCADA.	CL3
CO5	Apply the various concepts of SCADA on interfacing and 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	1					1		1				1	
CO2	3	2	1					1		1				1	
CO3	3	2	1					1		1		2		1	
CO4	3	2	1					1		1				1	
CO5	3	2	1					1		1		2		1	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

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

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

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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. 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):

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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AI APPLICATION IN ROBOTICS AND AUTOMATION

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA72224RC**	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:

- Computer Organization and System Architecture
- Data Modeling
- Sound knowledge of programming languages such as Python and R

COURSE OBJECTIVES:

Students will be able

Study the concepts of Artificial Intelligence.
Learn the methods of solving problems using Artificial Intelligence.
Introduce the concepts of Expert Systems and machine learning.
Learn about planning and reasoning artificial intelligence.
Solve the risk in artificial intelligence.

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: History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents. PROBLEM SOLVING: Solving problems by searching –Informed search and exploration–Constraint satisfaction problems– Adversarial search, knowledge and reasoning– knowledge representation – first order logic.	**8 Hours**
MODULE - II	
Planning: Planning with forward and backward State space search – Partial order planning – Planning graphs– Planning with propositional logic – Planning and acting in real world.	**8 Hours**
MODULE - III	
Reasoning: Uncertainty – Probabilistic reasoning–Filtering and prediction– Hidden Markov models–Kalman filters– Dynamic Bayesian Networks, Speech recognition, making decisions.	**8 Hours**
MODULE - IV	
Learning: Forms of learning – Knowledge in learning – Statistical learning methods – reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.	**8 Hours**
MODULE - V	
AI In Robotics: Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence.	**8 Hours**

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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 historical evolution and current state of AI in robotics, recognize the importance of human-like thinking in AI.	CL3
CO2	Understand planning techniques using forward and backward state space search, understand partial order planning, employ planning graphs, leverage propositional logic for planning.	CL3
CO3	Apply filtering and prediction through Hidden Markov models and Kalman filters, understand Dynamic Bayesian Networks, and implement decision-making in speech recognition scenarios.	CL3
CO4	Apply statistical and reinforcement learning methods, understand communication dynamics, and implement probabilistic language processing for effective perception and action.	CL3
CO5	Integrating AI into robotics through understanding robotic perception, localization and mapping, planning under uncertainty, dynamics and movement control, and AI ethics and risks.	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			3
CO2	3	3	2					2				2			3
CO3	3	3	3					2				2			3
CO4	3	3	3					2				2			3
CO5	3	3	3					2				2			3

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

ASSESSMENT STRATEGY

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

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

ASSESSMENT DETAILS

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

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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. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approach”, Pearson Education, India 2003.
2. Negnevitsky, M,“Artificial Intelligence: A guide to Intelligent Systems”, Harlow: Addison-Wesley, 2002.
3. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1992.

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

1. NPTEL Video on Fundamentals of Artificial Intelligence-https://youtu.be/pKeVMlkFpRc?si=YuNqDEDe8JK62NxD
2. NPTEL Video on Introduction to Robotics - https://youtu.be/a6_fgnuuYfE?si=4vm1CAtm5xsgv4FZ

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COMPUTER VISION

(Effective from the Academic Year 2023 - 2024)

VII SEMESTER

Course Code	**RA72224RD**	CIA Marks	50
Number of Contact Hours/Week (L: T: P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	**40L**	Exam Hours	03

CREDITS – 3

COURSE PREREQUISITES:

- Fundamental knowledge of Mathematics, computer organization, software engineering

- Review image processing techniques for computer vision
- Explain shape and region analysis
- Illustrate Hough Transform and its applications to detect lines, circles, ellipses
- Contrast three-dimensional image analysis techniques, motion analysis and applications of computer vision 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
- Activity/Problem Based Learning
- Case Studies
- MOOC/NPTEL Courses
- Any other innovative initiatives with respect to the Course contents

COURSE CONTENTS

MODULE - I	
CAMERAS: Pinhole Cameras, Radiometry – Measuring Light: Light in Space, Light Surfaces, Important Special Cases, Sources, Shadows, And Shading: Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, Color: The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color.	**8 Hours**
MODULE - II	
Linear Filters: Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates, Edge Detection: Noise, Estimating Derivatives, Detecting Edges, Texture: Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesis by Sampling Local Models, Shape from Texture	**8 Hours**
MODULE - III	
The Geometry of Multiple Views: Two Views, Stereopsis: Reconstruction, Human Stereposis, Binocular Fusion, Using More Cameras, Segmentation by Clustering: What Is Segmentation?, Human Vision: Grouping and Getstalt, Applications: Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels, Segmentation by Graph-Theoretic Clustering	**8 Hours**
MODULE - IV	
Segmentation by Fitting a Model: The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness, Segmentation and Fitting Using Probabilistic Methods: Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice, Tracking With Linear Dynamic Models: Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications and Examples.	**8 Hours**
MODULE - V	

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Geometric Camera Models: Elements of Analytical Euclidean Geometry, Camera Parameters and the Perspective Projection, Affine Cameras and Affine Projection Equations, Geometric Camera Calibration: Least-Squares Parameter Estimation, A Linear Approach to Camera Calibration, Taking Radial Distortion into Account, Analytical Photogrammetry, An Application: Mobile Robot Localization, Model- Based Vision: Initial Assumptions, Obtaining 8 Hours Hypotheses by Pose Consistency, Obtaining Hypotheses by pose Clustering, Obtaining Hypotheses Using Invariants, Verification, Application: Registration In Medical Imaging Systems, Curved Surfaces and Alignment.	**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	Implement fundamental image processing techniques required for computer vision, Perform shape analysis	CL3
CO2	Implement boundary tracking techniques, Apply chain codes and other region descriptors	CL3
CO3	Apply Hough Transform for line, circle, and ellipse detections.	CL3
CO4	Apply 3D vision techniques and implement motion related techniques	CL3
CO5	Develop applications using computer vision 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	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
CO5	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

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	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. R. Davies: Computer and Machine Vision – Theory, Algorithms and Practicalities, Elsevier (Academic Press), 4th edition, 2013.
2. David A. Forsyth and Jean Ponce: Computer Vision – A Modern Approach, PHI Learning (Indian Edition), 2009

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

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Applied Artificial Intelligence Lab

(Effective from the Academic Year 2022 - 2023)

VII SEMESTER

Course Code	**RA722L5R**	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:

- Advanced understanding of Linear algebra such as vector and matrix operations for an in-depth understanding of ML algorithms.

COURSE OBJECTIVES:

This course will enable students to:

- Implement and evaluate AI and ML algorithms in and Python programming language.

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	Implement A* Search algorithm.
2	Implement AO* Search algorithm.
3	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithmto output a description of the set of all hypotheses consistent with the training examples.
4	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge toclassify a new sample.
5	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
6	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
7	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.
8	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
9	Implement the non-parametric Locally Weighted Regressionalgorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs

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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 good programming skills to formulate the solutions for computational problems.	CL3
CO2	Design and develop solutions for informed and uninformed search problems in AI.	CL4
CO3	Utilize advanced package like NLTK for implementing artificial intelligence.	CL2
CO4	Demonstrate and enrich knowledge to select and apply AI tools to synthesize information and develop models within constraints of application area	CL2
CO5	Develop a minor project in multidisciplinary areas to demonstrate team work through reports and presentation	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	1	1	
CO2	3	2	3		2							1	1	1	
CO3	3	2	3		2							1	1	1	
CO4	3	2	3		2							1	1	1	
CO5	3	2	3		2							1	1	1	
3: Substantial (High)					2: Moderate (Medium)					1: Poor (Low)					

ASSESSMENT STRATEGY

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

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

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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=DG0AHxZa7A8
2. https://www.youtube.com/watch?v=0IKgIcT-QgY

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