

Class: S. Y. B. Tech. (Robotics & Automation)

Semester: III

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
RA201	Fundamentals of Robotics & Automation	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50			----	----
RA203	Engineering Mechanics	2	-	-	2	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50			----	----
RA205	Sensors and Instrumentation	3	-	2	4	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50			----	----
RA207	Analog and Digital Electronics	2	-	-	2	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50			----	----
RA209	Materials and Manufacturing Technology	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50			----	----
	Multidisciplinary Minor - I	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50			----	----
RA211	Engineering Mechanics Lab.	-	-	2	1	ISE	----	----	100	50	
RA213	Analog and Digital Electronics Lab.	-	-	2	1	ISE	----	----	100	50	
RA215	Object Oriented Programming Lab.	-	-	2	1	ISE	----	----	50	50	
						ESE	----	----	50	50	
RA219	Robotics Technology Lab I	-	-	2	1	ISE	----	----	50	25	
						ESE	----	----	50	25	
	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	----	----	100	50	
	TOTAL	16	-	12	22						
	TOTAL CONTACT HOURS	28									

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : 28

Total Credits : 22

Professional Skills Development and Foreign Languages Courses

Sr. No.	Course Name	Course Code
1	Professional Leadership Skills	SH2634
2	Interpersonal Skills	SH2614
3	Innovation Tools and Methods for Entrepreneurs	SH2694
4	Personal Effectiveness and Body Language	SH2594
5	German Language – III	SH2734
6	Japanese Language – III	SH2714

Note:

1. A student has to complete any two courses out of six choices offered under Choice Based Professional Skills Development Programme. A course in each semester will be allocated without any repetition.
2. Foreign Language course selected in F. Y. B. Tech. Sem-I will remain the same with next levels in Sem-III & IV. (No new entries in S. Y. B. Tech. Sem-III)

Class: S. Y. B. Tech. (Robotics & Automation)

Semester: IV

Course Code	Course	Teaching Scheme				Evaluation Scheme						
		L	T	P	Credits	Scheme	Theory (Marks %)			Practical (Marks %)		
							Max.	Min. for Passing		Max.	Min. Passing	for
RA202	Mathematics for Robotics & Automation	3	-	-	3	ISE	20	40	40	---	---	
						UT1	15			---	---	
						UT2	15			---	---	
						ESE	50			40	---	---
RA204	Strength of Materials	3	-	-	3	ISE	20	40	40	---	---	
						UT1	15			---	---	
						UT2	15			---	---	
						ESE	50			40	---	---
RA206	Control Systems	3	-	2	4	ISE	20	40	40	---	---	
						UT1	15			---	---	
						UT2	15			---	---	
						ESE	50			40	---	---
RA208	Robot Kinematics	3	-	-	3	ISE	20	40	40	---	---	
						UT1	15			---	---	
						UT2	15			---	---	
						ESE	50			40	---	---
RA214	Electric Drives and Control	2	-	-	2	ISE	20	40	40	---	---	
						UT1	15			---	---	
						UT2	15			---	---	
						ESE	50			40	---	---
	Multidisciplinary Minor - II	3	-	-	3	ISE	20	40	40	---	---	
						UT1	15			---	---	
						UT2	15			---	---	
						ESE	50			40	---	---
RA210	Machine Drawing Lab.	-	-	2	1	ISE	---	----		50	25	
						ESE			50	25		
SH2174	<u>Environmental Science</u>	1	-	2	2	ISE	50	40	40	---	---	
						ESE	50	40		---	---	
RA216	Robotics Technology Lab II	-	-	2	1	ISE				50	25	
						ESE	---	----	50	25		
RA218	Mini Project	-	-	2	1	ISE	---	---		100	50	
RA220	Massive Open Online Courses (MOOC)	-	-	-	1	ISE	---	---		100	50	
	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	---	---		100	50	
	TOTAL	18	-	12	24							
	TOTAL CONTACT HOURS	30										

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : 30

Total Credits : 24



K. E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Syllabus for B.Tech. Robotics & Automation
To be Implemented for **2024-28** NEP Batch
Department of Robotics & Automation

- **Note: Students are required to undergo industrial / field training of minimum two weeks in the vacation of Semester-IV and its evaluation will be carried out in the Semester-V.**
- **Note: Students are required to undergo scholastic aptitude training of minimum two weeks in the vacation of Semester-IV and it's evaluation will be carried out in the Semester-V as an audit course.**

Professional Skills Development and Foreign Languages Courses

Sr. No.	Course Name	Course Code
1	Professional Leadership Skills	SH2634
2	Interpersonal Skills	SH2614
3	Innovation Tools and Methods for Entrepreneurs	SH2694
4	Personal Effectiveness and Body Language	SH2594
5	German Language – IV	SH2644
6	Japanese Language – IV	SH2624



Class: T. Y. B. Tech. (Robotics & Automation)

Semester: V

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)		
							Max	Min. for Passing	Max	Min. for Passing	
RA321	Industrial Automation	2	-	-	2	ISE	20	40	40	---	---
						UT1	15				
						UT2	15			---	---
						ESE	50			40	---
RA303	Design of Machine Elements	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50			40	---
	Program Elective - I	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50			40	---
	Open Elective - I	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50			40	---
	Multidisciplinary Minor - III	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50			40	---
RA323	Programmable Logic Controllers and SCADA	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15				
						ESE	50			40	---
	Multidisciplinary Minor - IV	1	-	2 [#]	2	ISE	---	---	50	50	
						ESE	---	---	50	50	
RA331	Mini Project - I	-	-	6	3						
RA313	PLC & SCADA Lab.	-	-	2	1	ISE	---	---	50	50	
						ESE	---	---	50	50	
RA325	Industrial Automation Lab.	-	-	2	1	ISE	---	---	100	50	
RA327	Engineering Analysis Lab	-	-	2	1	ISE	---	---	100	50	
RA319	Summer Internship	-	-	-	1	ISE	---	---	100	50	
RA329	Massive Open Online Course (MOOC)	-	-	-	1	ISE	--	---	100	50	
SH3035	Scholastic Aptitude- I	1	-	2	Audit	ISE	100	50 (P/NP)	---	----	
	TOTAL	17	-	16	25						
	TOTAL CONTACT HOURS	30+3*									

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : 33

Total Credits : 25

- # End Semester Examination of Multidisciplinary Minor - IV will be based on practical oral examination only.
- Note: Students are required undergo scholastic aptitude training of minimum two weeks in the vacation of Semester-V and it's evaluation will be carried out in the Semester-VI as an audit course.

- * Contact hours of scholastic aptitude are not accounted in teaching load during semester.

Program Elective – I:

Sr. No.	Course Code	Course
1	RA305	Industrial Design and Applied Ergonomics
2	RA307	Computer Integrated Manufacturing Systems
3	RA309	Finite Element Analysis
4	RA311	Wireless Sensors Networks for Robotics

Open Elective I 2024-28			
Sr. No.	Course Code	Open Elective Subject Name	Offered by the department
1	OE341	Energy Audit and Management	Electrical Engineering
2	OE343	Data Science	Computer Science & Engineering (Artificial Intelligence and Machine Learning)
3	OE365	Distributed Systems	Computer Science and Information Technology
4	OE361	Object Oriented Modeling and Design	Computer Science and Information Technology
5	OE3104	Network Administration	Computer Science and Engineering
6	OE3381	Disaster Management	Civil Engineering
7	OE3064	Environmental Impact Assessment	Civil Engineering
8	OE347	New Product Design & Development	Mechanical Engineering
9	OE349	Non-Conventional Energy Sources	Mechanical Engineering
10	OE3044	Renewable Energy Sources	Robotics & Automation
11	OE363	Robotics Engineering & Applications	Robotics & Automation
12	OE353	Factory Automation	Mechatronics Engineering
13	OE355	Cyber Physical System	Mechatronics Engineering
14	OE357	Internet of Things	Electronics & Telecommunication Engineering
15	OE359	Drone Technology	Electronics & Telecommunication Engineering
16	OE351	Hydrogen Fuel Cell Technology	Mechanical Engineering

Class: T. Y. B. Tech. (Robotics & Automation)

Semester: VI

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
RA302	Microcontrollers and Embedded systems	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
RA304	Research Methodology	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
	Program Elective - II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
	Open Elective - II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
	Multidisciplinary Minor - V	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
RA316	Programming and Simulation Lab	-	-	4	2	ISE	---	---		50	50
						ESE	---	---		50	50
RA318	Microcontrollers and Embedded Systems Lab	-	-	2	1	ISE	---	---		100	50
RA330	Python Programming Lab	-	-	2	1	ISE	---	---		100	50
SH3065	Scholastic Aptitude- II	1	-	2	Audit	ISE	100	50 (P/NP)		---	----
RA332	Minor Project	-	-	12	6	ISE	---	---		100	50
	TOTAL	15	-	22	24						
	TOTAL CONTACT HOURS	35+2*=37									

ISE = In Semester Evaluation, UT-1 = Unit Test-1, UT-2 = Unit Test-2, ESE = End Semester Exam.

Total Contact Hours/week : 37

Total Credits : 24

*** Contact hours of scholastic aptitude are not accounted in teaching load during semester.**

Program Elective – II:

Sr. No.	Course Code	Course
1	RA306	Fundamental of MEMS
2	RA308	Mechatronic System Design
3	RA310	Noise and Vibration
4	RA312	Lean Manufacturing

Open Elective II			
Sr. No.	Course Code	Open Elective Subject Name	Offered by the department
1	OE3084	Material Management	Civil engineering Department
2	OE350	Operations Research	Civil Engineering
3	OE358	Plumbing (Water and Sanitation)	Civil Engineering
4	OE372	Industrial Safety	Electrical Engineering
5	OE342	Data Mining	Computer Science & Engineering (Artificial Intelligence and Machine Learning)
6	OE368	AI for Agriculture	Computer Science & Engineering (Artificial Intelligence and Machine Learning)
7	OE3401	Cyber Security	Computer Science and Information Technology
8	OE364	AI for Manufacturing	Computer Science and Information Technology
9	OE348	Information Technology Foundation Program	Computer Science and Engineering
10	OE366	AI for Cybersecurity	Computer Science and Engineering
11	OE3284	Supply Chain Management	Mechanical Engineering
12	OE3324	Entrepreneurship Development	Mechanical Engineering
13	OE3024	Reliability Engineering	Robotics & Automation
14	OE362	Flexible Manufacturing System	Robotics & Automation
15	OE344	Supply Chain Analytics	Mechatronics Engineering
16	OE346	Mobile Robotics	Mechatronics Engineering
17	OE352	Image Processing	Electronics & Telecommunication Engineering
18	OE354	Fuzzy Logic & Neural Network	Electronics & Telecommunication Engineering
19	OE356	Project Management	Mechanical Engineering
20	OE370	AI for Sustainability	Electronics & Telecommunication Engineering
21	OE3242	Marketing for Engineers	MBA

Class: Final Year B. Tech. (Robotics & Automation)

Semester: VII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)		
							Ma x.	Min. for Passing	Ma x.	Min. for Passing	
RA401	Hydraulics and Pneumatics	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
RA447	AI & ML for Robotics	2	-	-	2	ISE	20	40	40	---	---
						UT1	15				
						UT2	15			---	---
						ESE	50	40		---	---
RA439	Industrial Engineering	3	-	-	3	ESE	50	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
RA441	Industrial Robots	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
	Program Elective – III	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
	Program Elective - IV	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
	Program Elective – IV Lab.	-	-	2	1	ISE	--	---		50	50
						ESE	--	---		50	50
RA443	Robot Kinematics and Dynamics Lab	-	-	2	1	ISE	--	---		50	50
						ESE	--	---		50	50
RA435	Hydraulics and Pneumatics Lab.	-	-	2	1	ISE	--	---		100	50
RA445	Advanced Manufacturing Lab.	-	-	2	1	ISE	--	---		50	50
	TOTAL	17	-	8	21						
	TOTAL CONTACT HOURS	25									

ISE = In Semester Evaluation, MSE = Mid Semester Exam, ESE = End Semester Exam.

Total Contact Hours/week : 25

Total Credits : 21

Program Elective – III:

Sr. No.	Course Code	Course
1	RA407	Cyber Security for Industrial Automation
2	RA409	Operations Research
3	RA411	Mobile Robotics
4	RA413	Electric & Autonomous Vehicles

Program Elective – IV:

Sr. No.	Course Code	Course
1	RA415	Industrial Internet of Things
2	RA417	Additive Manufacturing
3	RA419	Drone Technology
4	RA421	Product Lifecycle Management

Program Elective – IV Lab.:

Sr. No.	Course Code	Course
1	RA423	Industrial Internet of Things Lab
2	RA425	Additive Manufacturing Lab
3	RA427	Drone Technology Lab
4	RA429	Product Lifecycle Management Lab

Choice Based Internship Model
Model I: Industry Internship (II)

Class: Final Year B. Tech. (Robotics & Automation)

Semester: VIII

Class: Final Year B. Tech. (Robotics & Automation)											
Semester: VIII											
Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
OE4382	Finance for Engineers (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
OE4362	Engineering Management & Economics (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
IP4024	Industry Internship & Project	-	-	-	12	ISE	---	----	50	50	
						ESE	---	---		50	50
	TOTAL	-	-	-	16						

ISE: In Semester Evaluation, ESE: End Semester Exam

Total Contact Hours/week : --

Total Credits : 16

Note:

1] Weekly Contact hours are not mentioned as student is expected to be in industry regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.

2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit, there will be separate assignment. Students need to submit all assignments within specified time.

Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.

Model II: Research Internship (RI)

Class: Final Year B. Tech. (Robotics & Automation)

Semester: VIII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
OE4382	Finance for Engineers (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
OE4362	Engineering Management & Economics (Online Course)	2	-	-	2	ISE	25	40	40	---	---
						ESE	75	40		---	---
RE4044	Research Internship	-	-	-	12	ISE	---	---		50	50
						ESE	---	---		50	50
	TOTAL	-	-	-	16						

ISE: In Semester Evaluation, ESE: End Semester Exam

Total Contact Hours/week : --

Total Credits : 16

Note:

1] Weekly Contact hours are not mentioned as student is expected to be in outside research organization regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.

2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.

3] Students who opt for a research internship need to undergo a minimum of one month of research internship in outside research organizations or laboratories.

Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.

Model III: Entrepreneurial Internship (EI)

Class: Final Year B. Tech. (Robotics & Automation)

Semester: VIII

Course Code	Course	Teaching Scheme			Credits	Evaluation Scheme					
		L	T	P		Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for Passing		Max.	Min. for Passing
ED4104	Project Management (Online Course)	-	-	-	2	ISE	25	40	40	-	-
						ESE	75	40		-	-
ED4044	Commercial Aspects of the Project (Online Course)	-	-	-	2	ISE	25	40	40	-	-
						ESE	75	40		-	-
ED4064	Entrepreneurship Development Program (EDP)	-	-	-	1	ISE	---	--		100	50
ED4084	Entrepreneurial Internship	-	-	-	11	ISE	--	--		50	50
						ESE	--	--		50	50
	TOTAL	-	-	-	16						

ISE: In Semester Evaluation, ESE: End Semester Exam

Total Contact Hours/week : -

Total Credits : 16

Note:

1] Weekly Contact hours are not mentioned as student is expected to be in outside research organization regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.

2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.

3] Students who opt for an entrepreneurial internship need to undergo a minimum of one-month internship at an outside reputed organization or firm

Weightage: 25% weightage for unit wise assignments + 75% weightage for final exam. Final exam will be held at college campus.

4] A one-week Entrepreneurship Development Program (EDP) will be conducted after completion of 7th semester and before start of 8th semester.



B.Tech. in Robotics & Automation with Multidisciplinary Minor



Multidisciplinary Minor

- Student should choose any one specialization given by the department and complete all the five courses under the specialization
- Following are the baskets of multidisciplinary minor courses

Multidisciplinary Minor Baskets 24-28					
MDM Basket Name	Sr. No.	Course Code	Course Name	Semester	Offered by Department
Construction Engineering	1	CEMD201	Building Construction and Planning	III	Civil Engineering
	2	CEMD202	Building Estimation and Valuation	IV	
	3	CEMD301	Infrastructure Engineering	V	
	4	CEMD303	Smart Cities and Sustainable Development	V	
	5	CEMD302	Environmental Engineering	VI	
Software Programming	1	CSMD201	Introduction to Data Structures	III	Computer Science & Engineering
	2	CSMD202	Problem solving using JAVA	IV	
	3	CSMD301	Fundamentals of Database Systems	V	
	4	CSMD303	Object-oriented Programming in Python	V	
	5	CSMD302	Artificial Intelligence	VI	
Electrical Power System	1	EEMD201	Electrical Power Generation	III	Electrical Engineering
	2	EEMD202	Power System	IV	
	3	EEMD301	Electrical Machines	V	
	4	EEMD305	Electrical Technology	V	
	5	EEMD302	Smart Grid	VI	
Electronics System Design	1	ECMD201	Electronics Devices and Applications	III	Electronics & Telecommunication Engineering
	2	ECMD202	Electronics Communication Systems	IV	
	3	ECMD301	Advanced Communication Systems	V	
	4	ECMD303	Electronic Product Design	V	
	5	ECMD302	Industrial Electronics	VI	
	1	CIMD201	Data Structures	III	

Software Development	2	CIMD202	Computer Algorithms	IV	Computer Science & Information Technology
	3	CIMD301	Introduction to DBMS	V	
	4	CIMD303	OOP using Java	V	
	5	CIMD302	Software Engineering	VI	
Product Design and Development	1	MEMD203	Design Thinking	III	Mechanical Engineering
	2	MEMD204	Behavioral Engineering and Design	IV	
	3	MEMD305	Product Design Tools and Techniques	V	
	4	MEMD307	Design and Prototyping	V	
	5	MEMD304	Marketing and Business Fundamentals for New Products	VI	
Mechatronics Engineering	1	MCMD201	Fundamentals of Mechatronics	III	Mechatronics Engineering
	2	MCMD202	Industrial Fluid Power	IV	
	3	MCMD301	Sensor and Instrumentation	V	
	4	MCMD303	Industrial Automation	V	
	5	MCMD302	Industrial Robotics	VI	
Artificial Intelligence	1	AIMD201	Object Oriented Programming	III	Computer Science & Engineering (AI-ML)
	2	AIMD202	Data Structures and Algorithms	IV	
	3	AIMD301	Machine Learning	V	
	4	AIMD303	Business Intelligence	V	
	5	AIMD302	Principles of AI	VI	
Robotics & Automation	1	RAMD201	Fundamentals of Robotics & Automation	III	Robotics & Automation
	2	RAMD202	Sensors and Actuators	IV	
	3	RAMD301	Kinematic & Dynamics for Robots	V	
	4	RAMD305	Robot Programming	V	
	5	RAMD302	Industrial Automation & Control	VI	

B.Tech. in Robotics & Automation with Double Minor (Multidisciplinary and Specialization Minor)

Double Minor Degree

1. It is required to complete SIX courses (each of 3 credits) from ONLINE platform to earn total of 18 credits under Double Minor (DM) certification.
2. Student must complete and earn the credits for all the six courses starting from Second Year First semester (3rd semester) to Final Year Second Semester (8th semester).
3. Basket of the DM courses and respective semester is mentioned in the following table.

Sr. No.	Semester	Course	Code
1	III	DM – I	RADM3XXX
2	IV	DM – II	RADM4XXX
3	V	DM – III	RADM5XXX
4	VI	DM – IV	RADM6XXX
5	VII	DM – V	RADM7XXX
6	VIII	DM – VI	RADM8XXX

4. To select course platform, first preference must be given to NPTEL.
5. Other than NPTEL, courses from COURSERA and UDEMY platforms are allowed to register only in following cases,
 - a. If timeline of NPTEL course is not in line with timeline of academic calendar.
 - b. The suitable succeeding course in line with previous course is not available on NPTEL.
 - c. If any other unavoidable circumstances occur.
6. Platform and course selection must be as per recommendation of BoS of the department.
7. Student will get the credits of respective DM course in following conditions,
 - a. In case of course selected from NPTEL platform, student have to complete the timely assignments, PASS the exam and secure the certificate.
 - b. In case of course selected from COURSERA or UDEMY, student have to secure the certificate and appear for VIVA(oral) exam.
8. While selecting online course, following points must be taken care of,
 - a. Selected course must be of basic or fundamental level.
 - b. Contents of the course should not be covered in any of the course offered in regular curriculum or not listed in any elective (open or program elective) or in Multidisciplinary Minor (MDM)
 - c. Duration of each online course must be of EIGHT weeks for NPTEL and 30+ hours for UDEMY, COURSERA courses.

B.Tech. in Robotics & Automation with Honor and Multidisciplinary Minor

Honors with Multidisciplinary Minors

1. It is required to complete SIX courses (each of 3 credits) from ONLINE platform to earn total of 18 credits under Honor certification.
2. Student must complete and earn the credits for all the six courses starting from Second Year First semester (3rd semester) to Final Year Second Semester (8th semester).
3. Basket of the Honor courses and respective semester is mentioned in the following table.

Sr. No.	Course	Code
1	Honor - I	RAHNXXX
2	Honor - II	RAHNXXX
3	Honor - III	RAHNXXX
4	Honor - IV	RAHNXXX
5	Honor - V	RAHNXXX
6	Honor - VI	RAHNXXX

4. To select course platform, first preference must be given to NPTEL.
5. Other than NPTEL, courses from COURSERA and UDEMY platforms are allowed to register only in following cases,
 - a. If timeline of NPTEL course is not in line with timeline of academic calendar.
 - b. The suitable succeeding course in line with previous course is not available on NPTEL.
 - c. If any other unavoidable circumstances occur.
6. Platform and course selection must be as per recommendation of BOS.
7. Student will get the credits of respective Honor course in following conditions,
 - a. In case of course selected from NPTEL platform, student have to complete the timely assignments, PASS the exam and secure the certificate.
 - b. In case of course selected from COURSERA or UDEMY, student have to secure the certificate and appear for VIVA(oral) exam.
8. While selecting online course, following points must be taken care of,
 - a. Selected course must be of advanced level and not basic or fundamental level.
 - b. Contents of the course should not be covered in any of the course offered in regular curriculum or not listed in any elective (open or program elective)
 - c. Duration of each online course must be of EIGHT weeks for NPTEL and 30+ hours for COURSERA, UDEMY courses.

B. Tech. in Robotics & Automation - Honors with Research and Multidisciplinary Minor



Honors with Research and Multidisciplinary Minor

The student will work on Research Project or Dissertation for 18 Credits in the Fourth Year in respective discipline. The distribution of 18 Credits for Research project in Sem-VII and Sem-VIII is given below. To get B. Tech. in Robotics & Automation - Honors with Research and Multidisciplinary Minor degree, Student need to earn total 206 Credits which consist 170 credits of regular Multidisciplinary Minor courses, 18 Credits of Honor courses and 18 credits of Research courses.

Class: Final Year B. Tech.

Semester: VII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)			Practical (Marks %)	
							Max.	Min. for passing		Max.	Min. for passing
REH401	Intellectual Property Rights	-	-	-	2	ISE	50	40	40	---	---
						ESE	50	40		---	---
REH403	Research Project (Synopsis) Phase - I	-	-	-	2	ISE	--	--	--	50	50
						ESE	--	--		50	50
REH405	Research Specific Core Course - I (Online NPTEL course)	-	-	-	3	ISE	50	40	40	--	--
						ESE	50	40		--	--
	TOTAL	-	-	-	7						

ISE: In Semester Evaluation, UT-I: Unit Test-I, UT-II: Unit Test-II, ESE: End Semester Exam.

Note: For Evaluation of Online NPTEL course ISE Marks will be marks obtained by students in the assignments given by NPTEL, students who will secure NPTEL certification will be only eligible for ESE of the same course which will be conducted at institute

Class: Final Year B. Tech.

Semester: VIII

Course Code	Course	Teaching Scheme				Evaluation Scheme				
		L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)	
							Max.	Min. for passing	Max.	Min. for passing
REH402	Research Project Phase - II	-	-	-	11	ISE	--	--	50	50
						ESE	--	--		
	TOTAL	-	-	-	11					

ISE: In Semester Evaluation, UT-I: Unit Test-I, UT-II: Unit Test-II, ESE: End Semester Exam.

Class: Third Year B.Tech.	Semester-V	L	T	P	Credits
Course Code: RA321	Course Name: Industrial Automation	2	-	-	2

Course Description:

This course introduces the fundamentals of Industrial Automation, including automation types, manufacturing systems, transfer lines, material handling, storage systems, identification technologies, and quality control practices. It helps students understand real-world industrial systems, develop analytical and problem-solving skills, and prepare for careers in manufacturing, automation, and process industries.

Course Learning Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain need, basic elements, and systems of industrial automation.
- CO2. Analyse the single station cells, transfer lines, and assembly lines.
- CO3. Discuss various material handling and identification technologies.
- CO4. Suggest quality control and inspection techniques to improve manufacturing processes.
- CO5. Discuss the case studies of industrial automation.

Prerequisite: Manufacturing Process

Course Content

Unit No.	Description	Hrs
1.	Introduction to Industrial Automation Overview of automation, architecture of industrial automation system, requirements of automation systems, specifications of automation systems, automation strategies, basic components of automation systems, types of automation, levels of automation, Industrial Revolutions and automation technologies, Conventional Automation and Automation with Industry 4.0, Issues and challenges in automation.	04
2.	Automated Manufacturing Systems Fundamentals of manufacturing operations, processing, assembly and material handling, advanced automation functions, automation in manufacturing, configuration of automated flow lines, types of control systems, specifications of automation system, Cellular manufacturing, Flexible manufacturing system (FMS), Introduction to Smart Manufacturing, Case studies of automation in manufacturing	04
3.	Automated Material Handling Systems Overview of material handling systems: Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated Storage Systems: Storage System Performance,	04



K. E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Syllabus for B.Tech. Robotics & Automation
To be Implemented for **2024-28** NEP Batch
Department of Robotics & Automation

	Automated Storage/Retrieval Systems Automated flow lines and transfer mechanisms, Storage buffers, Analysis of transfer lines without storage, Analysis of automated transfer lines with storage buffers	
4.	Transfer Lines and Automated Assembly Single-Station Manned Cells, Single-Station Automated Cells, Enablers for Unattended Cell Operation, Parts Storage and Automatic Parts Transfer, Applications of Single-Station Cells, Analysis of Single-Station Cells. Fundamentals of manual assembly lines, Automated assembly system – design and types of automated assembly systems, Analysis of multi station and single station assembly machine.	04
5.	Transfer Devices and Feeders Transfer devices, types and applications of transfer devices, transfer mechanisms in transfer devices, selection of transfer devices, conveyor systems, feeders, classification of feeders, criteria for feeder selection, Process Safety Automation, Levels of process safety through use of PLCs, International Standards, Introduction to Internet of Things and Industrial Internet of Things and its application in industrial automation.	04
6.	Design of automation system Automation systems in an application, case studies of manufacturing industries and process industries: Automotive Assembly Line Automation, Warehouse and Material Handling Automation, Automated Bottling/Packaging System etc. System Specifications, Mechanical Description of the automation, Motion Sequence, Motor and Drive Mechanism Selection, Encoder Selection, Control Structure: Programmable Logic Controller used for Industrial Automation	04

References –

Text Books:

1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice-Hall.
2. M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley.

Reference Books:

1. Webb, John W. Programmable Logic Controllers: Principles and Application, Prentice Hall of India, New Delhi.
2. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Amber G.H & P.S. Amber, Anatomy of Automation, Prentice Hall.



Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code: RA303	Course Name: Design of Machine Elements	3	-	-	3

Course Description:

This course introduces the fundamental principles of designing machine elements used in robotics and automation systems. Students will learn design fundamentals along with failure theories in the introduction part. The focus of course is to design components like joints, shafts, keys, gears. Also, it provides exposure to select the belt drives and bearings from the manufacturer's catalogue. By the end of the course, students will be able to design machine elements that meet functional, economic, and manufacturability requirements

Course Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain steps of design and theories of elastic failure.
- CO2. Design joints for different loading conditions.
- CO3. Design shafts and keys to transmit the required amount of torque and power.
- CO4. Design different types of gears by using different considerations.
- CO5. Select the belt drives and bearings for particular applications.

Prerequisite: Engineering Mechanics, Engineering Materials, and Mechanics of Materials

Course Content		
Unit No.	Description	Hrs
1	Fundamentals of Machine Design: Introduction of Engineering Design, The Phases of Design, Design Considerations & Procedures, Modern Design Considerations, Factor of safety, Theories of Failures (Maximum principal stress theory and Maximum shear stress theory), additive manufacturing.	06
2	Design of Joints: Types of joints and Industrial Applications, Terminology of screw threads, bolted joint simple analysis, Bolted joints in tension and shear, design for eccentrically loaded threaded joint, Theoretical Concepts for self study: Cotter Joint, Socket & Spigot Joint, and Knuckle Joint	06
3	Design of Shafts and Keys: Design of shaft on the basis of strength, torsional rigidity, ASME code (Numerical treatment). Design of square and flat key, Kennedy key (Numerical treatment)	06
4	Belt Drives Introduction to drives, Belt Drives, Belt Constructions, Geometrical Relationships, Analysis of Belt Tensions, Condition for Maximum Power, Characteristics of Belt Drives, Selection of Flat-belts from Manufacturer's	06

	Catalogue, V-belts, Selection of V-belts.	
5	Design of Spur Gear Types of Gear, Terminology of Spur Gear, Force analysis, Number of teeth, Face width & Beam strength of gear tooth, Incremental dynamic tooth load, Effective load on gear tooth, Estimation of module based on beam strength and wear strength, Spur gear design for maximum power transmission.	06
6	Bearing Selection Bearings, Types of Bearings, Selection of Bearing-type, Static Load Carrying Capacity, Stribeck's Equation, Dynamic Load Carrying Capacity, Equivalent Bearing Load, Load-Life Relationship, Selection of Bearing Life, Load Factor, Selection of Bearing from Manufacturer's Catalogue, Bearing Failure—Causes and Remedies, Lubrication of Rolling Contact Bearings, and Mounting of Bearing	06

Text Books:

1. Bhandari V. B., Design of Machine Elements, Tata McGraw-Hill.
2. M.F. Spotts & T.E. Shoup, Design of Machine Elements, Pearson Education

Reference Books:

1. Joseph E. Shigley & Larry D. Mitchell, Mechanical Engineering Design, McGraw-Hill.
2. George E. Dieter, Engineering Design- A Material and Processing Approach, McGraw-Hill.
3. Robert C. Junivall, Fundamentals of Machine Component Design, John Wiley & Sons.
4. Paul H. Black & O. Eugene Adams Jr., Machine Design, Third Edition, McGraw-Hill.
5. PSG Design Data Book.

Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code:RA305	Course Name: Industrial Design and Applied Ergonomics	2	-	0	2

Course Description:

This course explores the principles of Industrial Design and Applied Ergonomics, focusing on the relationship between product functionality, user experience, and product design. Students will learn human-centered design approaches, ergonomic principles, and the impact of styling and aesthetics in product development. Through case studies and illustrations, they will develop skills in design thinking, industrial design, and ergonomic design while considering usability, safety, and sustainability. The course prepares students to create innovative, efficient, and user-friendly products for various industries, including consumer electronics, automotive, medical devices, and workplace ergonomics

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Contextualize industrial design with reference to product design.
- CO2. Apply the aesthetic and styling concepts to the product design.
- CO3. Apply ergonomic principles while designing the product/workspace.
- CO4. Use design thinking approach for experiential design.

Prerequisite: Nil

Course Content		
Unit No.	Description	Hrs.
1	Introduction and Background Introduction to product design, engineering design, industrial design-ergonomics and aesthetics, History and evolution of industrial design, role of industrial design engineers, Case-studies of few product designs	04
2	Industrial Design Aesthetics and ergonomics, Principles of visual design (balance, contrast, proportion), Colour theory and its impact on user perception, Concept of unity-concept of order with variety -concept of purpose style and environment, Style-components of style- house style, case studies reflecting current industry trends (e.g., digital products, inclusive design).	04
3	Fundamentals of Ergonomics Anthropometry, biomechanics, anatomy, physiology, psychology, ergonomic principles of design, cognitive ergonomics and usability, examples of applied ergonomics	04
4	Anthropometry Human skeletal system, static and dynamic measures, anthropometric and biomechanical evaluation facilities, statistical concepts for anthropometric data presentation, Use of anthropometry for product/facility design	04

5	Ergonomics and Safety Ergonomic assessment of workspaces, Occupational safety and risk analysis, Design interventions for reducing workplace injuries, Standards and regulations in ergonomic design, control and displays	04
6	Design Thinking Design thinking process, human-centered design principles, user experience and interaction design, conducting user research and testing	04

References

Text Books:

1. Karl T Ulrich, Steven D Eppinger, Product Design and Development, Tata McGraw-Hill, New Delhi.
2. Mark S. Sanders, Ernest J. McCormick, Human Factors in Engineering and Design, McGraw-Hill,

Reference Books-

1. Kevin, Otto and Wood, Product Design, Pearson Education.

Class: T.Y. B. Tech.	Semester - V	L	T	P	Credits
Course Code: RA307	Course Name: Computer Integrated Manufacturing Systems	2	-	--	2

Course Description:

Students need to acquire the knowledge of computer integrated Manufacturing (CIM) after getting conversant with conventional manufacturing methods. This course encompasses entire range of product development and manufacturing activities with the help of different software packages. The course intends to help the students to work on Group Technology, Material Requirement Planning and collection of factory data system.

Course Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the basic concepts of CIM.
- CO2. Apply the concepts in NC & CNC machine tools.
- CO3. Select G code & M code in NC/ CNC programming methods
- CO4. Design of CNC programming and its implementation.
- CO5. Apply adaptive control system in CIM.
- CO6. Discuss different Manufacturing System and case studies in industries.

Prerequisite: Basics of manufacturing systems

Course Content

Unit No	Description	Hrs
1.	Introduction Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – Concurrent Engineering - CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics– Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In Time Production, smart manufacturing, IoT, and digital twins.	04
2.	Fundamentals of Numerical Control: Basic concepts of NC, Classification of NC- Point to Point and contouring, Incremental and absolute system, Open loop and closed loop system, Advantages of NC. NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit, CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors,	04
3.	N.C part programming Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming	04

	with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming.	
4.	Computer Controls in NC CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control (DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC,	04
5.	Adaptive Control Machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control Machining	04
6.	Production Planning and Control and Computerized process planning Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control Planning (ERP). Industrial case studies	04

References-

Text Book:

1. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India.
2. Radhakrishnan P, Subramanyan S.and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi.

Reference Books:

1. Chang, T.C. and Wysk, R.A., Computer-aided manufacturing. Prentice Hall PTR.
2. Xu, X., Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control. Information Science Reference.
3. P.N. Rao, CAD/CAM Principles and Applications, McGrawhill.
4. Y. Koren & J.Benuri, Numerical control of machine tools -Khanna Publications
5. Groover, M.P., Automation, production systems, and computer-integrated manufacturing, Prentice Hall Press.
6. Weatherall, A., Computer integrated manufacturing: from fundamentals to implementation, Butterworth-Heinemann.

Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code: RA309	Course Name: Finite Element Analysis	2	-	0	2

Course Description:

Finite element methods is offered as the elective course at the sixth semester of Robotics and Automation undergraduate programme. Basically, finite element methods are a mathematical tool to solve real life problems. This subject is base for the numerical analysis of problems from different disciplines. Comparison with other analysis methods, meshing and formulation of finite element equation, structural static and dynamic analysis, higher order elements is the major contents of the syllabus

The course is introductory undergraduate level and build the necessary theoretical background for development of finite element codes.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Discretize the physical domain using appropriate elements
- CO2. Check the quality of the finite element model.
- CO3. Develop FEA codes for structural analysis of robot linkages.
- CO4. Analyze dynamic behavior of the robot using FEA.
- CO5. Use isoparametric formulation for irregular geometries.

Prerequisite: The prerequisite for study of this subject from the student's end is that they must have undergone calculus and matrix algebra. The students must have adequate knowledge about theory of elasticity, dynamics, which can be enhanced further.

Course Content		
Unit No.	Description	Hrs
01	Introduction Basic idea of FEM, comparison with experimental and analytical methods, comparison with other numerical methods, Steps of finite element analysis, direct stiffness method.	04
02	Discretization Discretization-need, element types, selection of elements, no of elements, node numbering scheme, element quality checks, Meshing Techniques, Checking of finite element models. Thumb rules of discretization.	04
03	Interpolation models Need of interpolation polynomial, classification of elements based on polynomial. Simplex complex multiplex elements, Compatibility and completeness requirement. Shape functions, global, natural and local coordinate system. Linear and higher order elements.	04
04	Structural analysis	04

	Basic concepts of theory of elasticity, Variational formulation of structural problems, One dimensional linear and higher order elements. Assembly and solution of finite element equations.	
05	Analysis of truss and beams. Truss Analysis- Transformation matrix, Element stiffness matrix, formulation of FE equation for truss element. Beam Analysis - Hermite interpolation polynomial, beam element stiffness matrix, FE equation for beam element.	04
06	Dynamic analysis. Natural frequency analysis, Galerkin method, axial vibration of bar, transverse vibration of beam. Consistent mass matrix and lumped mass matrix.	04

References –

Text Books:

1. Rao S. S., Finite Elements Method in Engineering, Elsevier,
2. Nitin Gokhale, Sanjay Deshpande, Sanjeev Bedekar, Anand Thite, Practical Finite Element Analysis, Finite to Infinite Pune

Reference Books:

1. Robert D Cook, Concepts and applications of finite element analysis, JohnWiley & Sons,
2. David V Hutton, Fundamentals of Finite element analysis, Tata McGraw Hill
3. Frank L. Stasa, Applied Finite Element Analysis for Engineers, CBS International Edition.
4. J. N. Reddy, Finite Element Method, McGraw -Hill International Edition.
5. Bathe K. J. Finite Elements Procedures, PHI.
6. Chandrupatla T. R., Finite Elements in engineering, PHI.

Class: T.Y. B.Tech.	Semester- V	L	T	P	Credits
Course Code: RA311	Course Name: Wireless Sensors Networks for Robotics	2	-	0	2

Course Description:

The course aims at understanding an important field of study i.e. Robotics Wireless Sensor Networks, which is the field at the intersection of Robotics and Wireless Sensor Networks. The successful completion of the course will enable the students to explore the industrial applications of Wireless Sensor Networks (WSN) in Robotics. In order to ensure this, course introduces fundamentals concepts, communication protocols and localization and navigation techniques in Robotics enabled with Wireless Sensor Networks. The impact of Artificial Intelligence and Machine Learning and the concept of security and reliability in WSN enabled Robotics is also covered in the course.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain the fundamental concepts of Wireless Sensor Networks (WSNs) and their role in Industry 4.0.
- CO2. Apply wireless communication protocols for real-time data transmission in robotic sensor networks.
- CO3. Design and develop secure and efficient WSN architectures for robotic applications.
- CO4. Discuss the industrial applications of WSN in Robotics

Prerequisite: Analog and Digital Electronics

Course Content		
Unit No.	Description	Hrs
1	Introduction to Wireless Sensor Networks (WSNs) Overview of Wireless Sensor Networks, Applications, and Unique Constraints, Role of WSNs in Industry 4.0 and Industrial IoT (IIoT), WSN architecture: Nodes, Clustering, Communication Models, Energy efficiency and power management in sensor networks, Platforms for WSN: Sensor Node Hardware (e.g., Mica2, TelosB, Cricket), Sensor Node Software: TinyOS and Contiki. Case studies: Smart factories, predictive maintenance.	6
2	Wireless Communication Protocols for Robotics Network Architecture: Design Principles of WSNs, Physical Layer and Transceiver Design Considerations, MAC Protocols: Fundamentals, Low Duty Cycle Protocols, Contention-Based Protocols (e.g., CSMA, PAMAS), Scheduling-Based Protocols (e.g., LEACH, SMACS), IEEE standards: 802.15.4, Zigbee, LoRa, NB-IoT, Wi-Fi 6, 5G, Low-power communication strategies for robotic applications, Edge computing and Fog computing in WSNs, Real-time data transmission and security challenges in robotic networks	6

3	Security and Reliability in WSN-Enabled Robotics (6 hours) Cybersecurity challenges in WSN for robotics, Encryption and authentication techniques, Fault tolerance and network resilience, Industry applications: Cyber-physical systems, secure industrial automation, Zero-Trust Labs and Post-Quantum Security principles.	6
4	Industrial Applications and Industry 4.0 Trends in WSN for Robotics Smart Manufacturing and Digital Twins, Collaborative Robots (Cobots) and Sensor Integration, Autonomous Mobile Robots (AMRs) and Automated Guided Vehicles (AGVs), Robotics as a Service and Cloud Robotics, Internet of Robotic Things (IoRT) and IoT Integration, Case Studies from Industry 4.0 Applications (Siemens, Bosch, ABB, etc.), Future Trends: 6G, AIoT (Artificial Intelligence of Things), and Bio-Inspired Sensor Networks.	6

References –

Text Books:

1. Holger Karl & Andreas Willig. Protocols And Architectures for Wireless Sensor Networks, John Wiley.
2. Swami Ananthram. Wireless Sensor Networks, Wiley India Pvt. Ltd, New Delhi, 2014.

Reference Books:

1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks- Technology, Protocols, And Applications, John Wiley.
2. Anna Hac, Wireless Sensor Network Design, John Wiley.
3. Steve Mackay, Edwin Wright, Deon Reynders, John Park, "Practical Industrial Data Networks: Design, Installation and Troubleshooting," First edition, Newnes publication, Elsevier.
4. John Park, Steve Mackay, Edwin Wright, "Practical Data Communications for Instrumentation and Control," First edition, Newnes publication, Elsevier, 2003.

Class:- T.Y. B. Tech.	Semester- V	L	T	P	Credits
Course Code : OE341	Course Name: Energy Auditing and Management	3	–	–	3

Course Description:

This course provides basic understanding of energy audit and management. Essential theoretical and practical knowledge about the concept of energy conservation, energy management, and different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in the commercial and industrial sector will be achieved through this course.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Identify the important of Energy Scenario.
2. Use energy audit knowledge to carry out energy audit of a given firm.
3. Examine different rolls in energy action planning
4. Apply project finance and management skills to carry out energy audit
5. Plan for energy monitoring and targeting.

Prerequisite: Electric Machines, Thermal Systems and Finance Management

Course Content		
Unit No	Description	Hrs
1	Energy Scenario : Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment, Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features. AI applications in energy sector	06
2	Energy Management and Audit : Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments, suitable case study for energy audit.	06
3	Energy Action Planning Key elements, Force field analysis, Energy policy purpose, perspective, Contents, Formulation, Ratification, Organizing –location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability. Motivating-motivation of employees: Information system-designing barriers, Strategies; Marketing and communicating-training and planning.	06

4	Financial Management Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs	06
5	Project Management Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification	06
6	Energy Monitoring And Targeting Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM). Suitable case study.	06

References -

Text Books:

- Amit Kumar Tyagi, Handbook on Energy Audits and Management, TERI Publication
- Wayne C. Turner, Energy Management Handbook, Wiley Inter Science Publication

Reference Books:

- P. O'Callaghan, Energy Management, McGraw - Hill Book Company
- Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I

Class:- T. Y. B. Tech.	Semester- V	L	T	P	Credits
Course Code: OE343	Course Name: Data Science	3	-	-	3

Course Description:

The course helps to learn concepts, techniques and tools they need to deal with various facets of data science practice, including data collection and integration. The orientation of course is to understand the basic types of data and basic statistics. The organization of data inline to Vectors, Matrices and Frames are examined. The Conditionals and Control Flow of data over R programming is to be implemented. Additionally, it will assist in identifying the importance of data reduction and data visualization techniques.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Articulate basic terms what Statistical Inference means
2. Analyze the data using various statistical measures
3. Identify data organization techniques used as foundations for modelling data
4. Utilize R elements for data handling
5. Perform data reduction and apply visualization techniques

Prerequisite: Basic Mathematics, Descriptive statistical techniques

Course Content		
Unit No	Description	Hrs
1	Introduction Definition of Data Science- Big Data and Data Science hype – and getting past the hype - Datafication - Current landscape of perspectives - Statistical Inference - Populations and samples - Statistical modeling, probability distributions, Basics of R programming.	06
2	Data Types Types of Data: Attributes and Measurement, What is an Attribute? The Type of an Attribute, The Different Types of Attributes, Describing Attributes by the Number of Values, Asymmetric Attributes, Binary Attribute, Nominal Attributes, Ordinal Attributes, Numeric Attributes, Discrete versus Continuous Attributes.	06
3	Statistical Description of Data Measuring the Central Tendency: Mean, Median, and Mode, Measuring the Dispersion of Data: Range, Quartiles, Variance, Standard Deviation, and Interquartile Range, Graphic Displays of Basic Statistical Descriptions of Data.	06

4	Data Organization Vectors: Creating and Naming Vectors, Vector Arithmetic, Matrices: Creating and Naming Matrices, Matrix Sub setting, Arrays, Factors and Data Frames: Introduction to Factors, Factor Levels, Summarizing a Factor, Introduction to Data Frame.	06
5	Conditionals and Control Flow Relational Operators, Relational Operators and Vectors, Logical Operators, Logical Operators and Vectors, Conditional Statements. Iterative Programming in R, Functions in R.	06
6	Data Reduction and Visualization Overview of Data Reduction Strategies, Principal Components Analysis, Attribute Subset Selection, Data Cube Aggregation. Data Visualization: Pixel - Oriented, Visualization Techniques.	06

References -

Text Books:

- Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from The Frontline", O'Reilly
- Jiawei Han, Micheline Kamber and Jian Pei., "Data Mining: Concepts and Techniques", The Morgan Kaufmann Series in Data Management Systems
- K G Srinivas, G M Siddesh, "Statistical programming in R", Oxford Publications

Reference Books:

- Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, "Introduction to Data Mining", Pearson Education
- Brain S. Everitt, "A Handbook of Statistical Analysis Using R", 4 LLC
- Dalgaard, Peter, "Introductory statistics with R", Springer Science & Business Media
- Paul Teetor, "R Cookbook", O'Reilly

Class:- T.Y. B. Tech	Semester-V
Course Code : OE365	Course Name : Distributed Systems

L	T	P	Credits
3	--	--	3

Course Description:

This course provides elementary introduction to fundamental concepts and principles of distributed systems. It elaborates the architecture, design, and implementation of distributed systems, emphasizing resource sharing, coordination, and communication among networked computers. The course covers system models, networking principles, operating system support, web services, and distributed file systems. It makes students aware about the complexities and challenges involved in designing and managing distributed systems.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Describe the basic principles and characteristics of distributed systems.
2. Explain different models of distributed systems and understand their applications.
3. Apply fundamental networking principles and Analyze internet protocols.
4. Comprehend the role of operating systems in supporting distributed systems, including processes, threads, communication, and virtualization.
5. Develop and secure web services for distributed applications.
6. Analyze distributed file system architecture.

Prerequisite: Basics of Computer Networks

Course Content

Unit No	Description	Hrs
1.	Characterization of Distributed Systems Introduction to distributed system, Examples of distributed systems, Trends in distributed systems, Focus on resource sharing, Challenges.	04
2.	System Model Introduction, Physical models, Architectural models – Client-Server model, Peer-to-Peer model, Layered Model, Micro-services Model, Fundamental models – Interaction Model, Remote Procedure Call, Security Model.	06
3.	Networking and Internetworking Introduction, Types of networks, Network principles, Internet protocols, Case studies: Ethernet, WiFi and Bluetooth.	06

4.	Operating System Support Introduction, Operating system layer, Protection, Processes and threads, Communication and invocation, Operating system architecture, Virtualization at the operating system level.	07
5.	Web Services Web services, Service descriptions and IDL for web services, A directory service for use with web services, XML security, Coordination of web services, Applications of web services.	07
6.	Distributed File System Introduction, Features of DFS, File service architecture, Applications of DFS, Case study: Sun Network File System, Case study: The Andrew File System, Enhancements and further developments.	06

References -

Text Books:

- George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, "Distributed Systems Concepts and Design", Pearson.

Reference Books:

- Andrew S. Tanenbaum, Maarten Van Steen, "Distributed Systems: Principles and Paradigms", Pearson

Class:-T.Y. B. Tech.	Semester-V		L	T	P	Credits
Course Code:- OE361	Course Name :Object Oriented Modeling & Design		3	--	--	3

Course Description:

This course introduces students to the design of software models by the ways of expressing some sort of abstract language or diagrams are used to express the software design. Software analysis and design includes all activities, which help the transformation of requirement specification into implementation. Requirement specifications specify all functional and non-functional expectations from the software. These requirement specifications come in the shape of human readable and understandable diagrams. Object-oriented software design, an object modeling language such as UML is used to develop and express the software design. UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Identify object classes and build the domain model using advanced concepts in object, dynamic and functional modeling.
- CO2. Apply different object-oriented design techniques.
- CO3. Design models using UML diagrams for software systems: use case, class, sequence, collaboration, activity, state chart diagrams, component and deployment.
- CO4. Design software systems using open source and advanced modeling tools.
- CO5. Evaluate designs of software systems in mini-projects, projects using Software Modeling & Design concepts.

Prerequisite: Basic knowledge of Software Engineering and object oriented programming.

Course Content		
Unit No	Description	Hrs
1.	Introduction to Object Modeling Object Oriented development & themes, Modeling as a Design Technique, Objects, classes, links and associations, generalization and inheritance, Aggregation, abstract classes, generalization as extension and restriction, multiple inheritance, metadata, candidate keys and inheritance.	06
2.	Dynamic & Functional Modeling Events, states, operations, concurrency, nested state diagrams, advanced dynamic modeling concepts, DFD, Case Study to draw nested state diagrams, Dynamic diagrams and DFD using UML tools.	06
3.	Design Methodology	06

	Preview of OMT technology, Impact of an object oriented approach, Analysis, System design with examples, combining models, Designing models, Comparing Methodologies using structured analysis and design.	
4.	Structural Modeling using UML Classes, Relationships, Common mechanisms. Diagrams, Class Diagrams, Interfaces, Types and Roles, Packages, Instances and Object Diagram, Case Study on class and object diagrams.	06
5.	Behavioral Modeling using UML Interactions, Use cases, Use case diagram, Interaction Diagrams and Activity diagrams, Events and signals, State Machines, Processes and Threads, Time and space, State chart diagrams, Case Study on use case, interaction, activity and state chart diagrams.	06
6.	Architectural Modeling using UML: - Components, Deployment, Collaboration, Patterns and Frameworks, Component diagrams and Deployment Diagrams, Case Study on Components, Deployment, Collaboration diagrams.	06

References -

Text Books:

- Michael Blaha, James R. Rumbaugh, William Premerlani, James Rumbaugh, "Object-Oriented Modeling and Design with UML" Pearson, Second Edition.
- Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Language User Guide", Pearson, Second Edition.

Reference Books:

- Andrew High, "Object Oriented Analysis and Design", McGraw Hill Education, First Edition.
- Mark Priestley, "Practical Object Oriented Design with UML", McGraw-Hill Education, Second Edition.

Class:- TY BTech	Semester- V	L	T	P	Credits
Course Code : OE 3104	Course Name : Network Administration	3	-	-	3

Course Description:

This course introduces the fundamental concepts of computer networks and network administration for students from non-software engineering disciplines. It covers essential networking concepts, network devices, IP addressing, basic network configuration, security, troubleshooting, and network monitoring to help students understand the role of networking in modern industrial and organizational environments.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the fundamental concepts of computer networking and their applications in industrial and organizational environments.
- CO2. Apply IP addressing techniques and perform basic network configuration for connected systems and devices.
- CO3. Demonstrate the configuration and management of common networking devices such as switches, routers, and wireless access points.
- CO4. Analyze basic network security measures and safe communication practices in networked systems.
- CO5. Evaluate and troubleshoot small-scale networks to ensure proper maintenance, connectivity, and security using standard networking practices.

Prerequisite:

Basic knowledge of computer fundamentals ,Familiarity with internet usage and computer hardware

Course Content		
Unit No	Description	Hrs
1	Introduction to Computer Networks – Introduction to Computer Networks, Importance of Networking in Industrial and Organizational Applications, Types of Networks (LAN, MAN, WAN), Network Topologies, Basics of OSI and TCP/IP Models, Network Devices – Hub, Switch, Router, Bridge, Gateway, Introduction to Transmission Media (Guided and Unguided)	6
2	IP Addressing and Network Configuration – Basics of IPv4 Addressing, Introduction to Subnetting, Private and Public IP Addresses, DHCP and DNS Concepts, Basic Network Configuration in Windows and Linux Systems,	6
3	Network Devices and Wireless Communication – Introduction to VLAN Concepts, Routing Basics, Wireless Networks, Wi-Fi Standards, Wireless Access Points and their Applications in Industrial and Office Environments, Mobile and Cellular Networks (GSM, CDMA)	6
4	Network Setup and Administration – Role of Network Administration in Organizations, Basic Network Installation and Setup, User and Resource Management, File and Print Sharing Services, Introduction to Network Monitoring Tools, Backup and Recovery Concepts	6
5	Basics of Network Security – Fundamentals of Network Security, Common Network Threats and Attacks, Basics of Firewall Configuration, VPN Concepts, Password Policies and Access Control Mechanisms	6
6	Network Troubleshooting and Maintenance Practices – Basics of Network Troubleshooting, Common Connectivity Problems, Diagnostic Tools (Ping, Traceroute, Netstat, IPConfig), Introduction to Performance Monitoring, Network Documentation, Maintenance Practices and Safety Considerations.	6

References -

Text Books:

- Computer Networks – Andrew S. Tanenbaum, Pearson Education.
- Networking All-in-One For Dummies – Doug Lowe, Wiley.

Reference Books:

- Data Communications and Networking – Behrouz A. Forouzan, McGraw Hill.
- Network+ Guide to Networks – Jill West, Cengage Learning.
- Network Security Essentials – William Stallings, Pearson.

Class: T. Y. B. Tech.	Semester: V	L	T	P	Credits
Course Code: OE3381	Course Name: Disaster Management	3	-	-	3

Course Description:

This course provides a holistic understanding of disaster management, covering both natural and manmade disasters. Students will delve into the meaning, nature, and various types of disasters, exploring their effects on individuals, communities, and the environment. The course encompasses a global perspective while focusing on the disaster profile of India, considering regional and seasonal variations.

Course Learning Outcomes:

After successful completion of the course, students will be able to,
 CO1. Outline disaster and disaster management cycle.
 CO2. Summarize disaster preparedness and response activities for various types of disaster.
 CO3. Apply various advanced techniques for disaster management.
 CO4. Examine role of various agencies in disaster management.
 CO5. Analyze the disaster management scenario in India.

Prerequisite: Environmental Science

Course Content		
Unit No	Description	Hrs
1.	Natural Disaster Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic, eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.	06
2.	Manmade Disasters Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disasters -A Global View, Disaster Profile of India- Regional, and Seasonal.	06
	Disaster management cycle Introduction to Disaster Management Cycle: Mitigation, Preparedness, Response and Recovery. Disaster Mitigation, Hazard identification and vulnerability analysis, Mitigation strategies or measures.	06
4.	Disaster Preparedness, Response and Recovery Introduction to Disaster Preparedness, Disaster Risk Reduction (DRR), The Emergency Operation Plan (EOP). Introduction to Disaster Response, Aims of disaster response, Disaster. Response Activities, Modern and traditional responses to disasters, Modern methods of disaster response, Disaster	06

	Recovery, The Recovery Plan, Disasters as opportunities for development initiatives.	
5.	Role of technology in Disaster management Geographic Information System (GIS) and Disaster Management. GIS applications. Global Positioning System (GPS) and Disaster Management, Applications of GPS to Disaster management. Remote Sensing and its significance in Disaster Management.	06
6.	Role of Multiple Stakeholders in Disaster management Role of NGO's, Community based organizations, media, Central, State, District and Local Administration, armed forces, Police and other organizations.	06

References:

Codes of Practice:

- National Disaster Management Authority (NDMA). National Disaster Management Plan 2019.
- National Disaster Management Authority (NDMA). National Disaster Management Act 2005.

Text Books:

- Coppola, D. P. "Introduction to International Disaster Management", Elsevier USA.
- Singh R. B., "Disaster Management", Rawat Publication.

Reference Books:

- Reiter L., "Earthquake Hazard Analysis: Issues and Insight", Colombia University Press.
- Mileti D. S. "Disaster by Design: A Reassessment of National Hazards in United States", The National Academic Press.

Class: T. Y. B. Tech.	Semester: V
Course Code: OE3064	Course Name: Environmental Impact Assessment

L	T	P	Credits
3	-	-	3

Course Description:

Environmental impact assessment (EIA) is offered as open Elective for Undergraduate course (B. Tech) semester V. It deals with definitions and concepts, rationale and historical development of EIA, EIA in Engineering, Initial environmental examination, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Apply EIA methods to prepare a report.
- CO2. Analyse the all projects by using Environmental Impact assessment tool.
- CO3. Provide solution for decision making in Industrial Development Problem.
- CO4. Prepare EIA report for submission to concerned authority.

Prerequisite:

Possess basic knowledge of Environmental Science

Course Content		
Unit No	Description	Hrs
1.	Basic concepts of EIA Environmental Impact Assessment: Introduction, Stages of EIA, Origin of EIA, Establishments of Procedure: Legislative Option, Project Screening for EIA, Methods, Projects thresholds, Sensitive area criteria Matrices. Scope studies for Environmental Impact Studies (EIS). Preparation for EIS Planning, Public Participation and Review of EIS.	06
2.	Methods for impact assessment Background information, interaction matrix methodologies, network methodologies, mathematical modelling, environmental setting, environmental impact assessment methodology, documentation and selection process, environmental indices and indicators for describing affected environment, Life cycle assessment.	06
3.	Prediction and assessment of impact for air and noise environment Basic information of air quality, identification of type and quantity of air pollutant, existing air quality and air quality standards, impact prediction and assessment, mitigation. Basic information of noise, existing noise levels and standards, prediction of noise levels and assessment of impact, mitigations.	06

4.	Prediction and assessment of impact for water and soil environment Basic information of water quality (Surface water and ground water), water quality standards, identification of impact, prediction of impact and assessment, mitigations. Background information of soil environment, soil and ground water standards, prediction and assessment of impact for ground water and soil, mitigations.	06
5.	Prediction and assessment of impact on cultural and socioeconomic environment Basic information on cultural resources, rules and regulations for cultural resources like archaeological, historical structures, Cultural system, prediction and assessment of impact, mitigations. Basic information of socioeconomic environment, description of existing socioeconomic environment, prediction and assessment of impact, mitigation, resettlement and rehabilitation.	06
6.	AI applications Decision Methods for Evaluation of Alternative Categorization of Industries for seeking environmental clearance from concerned authorities, AI tools like Bayesian network, SCREENER, Calyx tm, ORBI, IMPACT, procedure for environmental clearance, procedure for conducting environmental impact assessment report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, post environmental monitoring.	06

References:

Text Books:

- Canter R.L., Environmental Impact Assessment, McGraw Hill International Edition.
- John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book Company.

Reference Books:

- R.R Barthwal, Environmental Impact Assessment, New Age International Publishers
- Abbasi, Environmental Impact Assessment, McGraw Hill International Edition.

Class:- T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code : OE347	Course Name : New Product Design and Development	3	--	--	3

Course Description:

Maximizing the success of new products and services can drive growth and shareholder value, lead to significant competitive advantage and leapfrog a company ahead of its competitors. However, innovation is risky and most new products fail in the marketplace. Often, failure is due to an ineffective process. Thus, expertise in the design and marketing of new products is a critical skill for all managers, inside and outside of the marketing department. In this course, we first focus on the tools and techniques associated with analyzing market opportunities and then focus on designing, testing, and introducing new products and services. This course will introduce the new product development process and cover the three main areas of focus:

- Discovery - opportunity identification
- Design - concept and product design, development and evaluation
- Delivery - innovative approaches to product launch and introduction.

Course Learning Outcomes:

This course is designed to familiarize students with the principles and practices in the development, design, Development and introduction of new products and services. After successful completion of the course, student will be able to:

- CO1. Identify the new product opportunities and sources of new product ideas.
- CO2. Elaborate the product life cycle and product design process.
- CO3. Integrate the customer and end-consumer needs into design process.
- CO4. Apply the concepts and tools like DFMA, VE and QFD in design process
- CO5. Assimilate the various product characteristics to design a novel product
- CO6. Participate in group work sessions and teams to become acquainted with the importance of teamwork and collaboration that is critical to new product success.

Prerequisite:

Course is open to all Students. The course demands application of creativity, sensitivity towards solving problems and liking for doing something new and creative.

Course Content		
Unit No.	Description	Hrs
1.	Discovery- Opportunity identification for new products: Product life cycle, need for new products, strategic planning and new product opportunity, sources of new product ideas, S curves and technology forecasting. Product idea generation, Product Design Process steps, creativity and innovation.	06
2.	Identifying Customer Needs:	06

	Understanding customer needs, Voice of the customer, Gathering customer needs, Design Thinking (organizing and prioritizing needs), Product mission statement, Benchmarking and establishing product specifications	
3.	Product Concept Generation, Selection and Testing: Concept generation process and methods, Concept selection mechanism and techniques, Concept Testing-Purpose, process and methods. Product Architecture-types, establishing architecture, Modular design. Prototyping	06
4.	Product Design Tools and Techniques: Design for manufacturing and assembly (DFMA), Product teardown and experimentation, Concurrent engineering, Quality function Deployment (QFD), Value engineering.	06
5.	Product Idealization: Basic elements: Line, texture, color, form, symmetry, balance, scale, mass, unity and variety. Concept of visual language and visual design. Negative space. Use of symmetry. Generation of patterns and textures using simple elements. Color, color combinations and its dimensions: hue, value and Chroma. Color meanings in traditions and psychological use of colors. Ergonomic considerations, Anthropometry.	06
6.	Product Takeoff and Market Entry: Economic analysis, life-cycle costing, sensitivity analysis Pricing, Packaging, Preparing a launch plan, Pricing and Marketing. Intellectual property rights (IPR)	06

References: -

Text Books:

- Ulrich, Eppinger, Anita Goel, Product Design and Development, McGraw Hill Publishing.
- Otto & wood, Product Design, Pearson Education, reprint.

Reference Books:

- Devdas Shetty, Design for product success, Society for Manufacturing Engineering.
- Charles Flursheim, Industrial Design in Engineering, the Design Council, London.

Class:- T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code: OE349	Course Name: Non-conventional Energy Sources	3	--	--	3

Course Description:

This course provides a comprehensive understanding of non-conventional or renewable energy sources, exploring the principles, technologies, and applications associated with harnessing sustainable energy. The focus is on alternative sources that are environmentally friendly and contribute to reducing dependence on conventional fossil fuels. Students will delve into the latest advancements, challenges, and opportunities in the field of non-conventional energy.

Course Learning Outcomes:

At the end of the course the student should be able to:

- CO1. Identify the need of requirement of renewable energy source
- CO2. Summarize the various available energy sources.
- CO3. Illustrate different technologies essential for conversion of renewable energy sources.
- CO4. Evaluate the performance of energy conversion systems for maximum efficiency
- CO5. Compare the various renewable energy technologies.
- CO6. Select appropriate renewable energy technology for specific application

Prerequisite: Nil

Course Content		
Unit No	Description	Hrs
1.	Basics of Energy Sources: World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilization – Renewable Energy Scenario in India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems	06
2.	Solar Energy: Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications	06
3.	Bio - Energy: Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Biomass Applications	06
4.	Wind Energy: Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects	06

5.	Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles. Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, and application of fuel cells	06
6.	Other Renewable Energy Sources: Tidal energy, Wave Energy – Open and Closed OTEC Cycles , Small Hydro-Geothermal Energy , Stored hydro energy, Principles of hydro power technology	06

References: -

Text Books:

- S P Sukhatme, Solar Energy, McGraw Hill Education
- G.D. Rai, Non-conventional energy sources, Khanna Publishers, New Delhi
- John Twidell , Renewable Energy Resources, Routledge

References:

- Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, U.K.
- Freris. L.L., Wind Energy Conversion Systems, Prentice Hall, UK
- David M. Mousdale, Introduction to Biofuels, CRC Press, Taylor & Francis Group, USA,
- B. H. Khan, Non-Conventional Energy, Tata McGraw-Hill, New Delhi,

Class: T.Y. B.Tech.	Semester- V	L	T	P	Credits
Course Code: OE3044	Course Name: Renewable Energy Sources	3	-	-	3

Course Description:

This course provides a comprehensive introduction to various renewable energy sources, including solar, wind, biomass, hydro, geothermal, and emerging technologies. It explores the fundamental principles, working mechanisms, and applications of these energy sources while emphasizing their role in sustainable development. Students will gain insights into energy storage solutions, smart grids, and the latest advancements in renewable energy integration. The course also covers environmental impacts, economic feasibility, and government policies promoting clean energy adoption. By the end of this course, students will be equipped with the knowledge to contribute to the development and implementation of renewable energy solutions in real-world scenarios.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain fundamental knowledge of various renewable energy sources and their importance.
- CO2. Describe the working principles, technologies, and applications of renewable energy systems.
- CO3. Analyze the environmental impact and economic feasibility of renewable energy solutions.
- CO4. Investigate recent advancements and future trends in sustainable energy technologies.

Prerequisite: Engineering Physics, Engineering Chemistry, Basics of Mechanical Engineering

Course Content		
Unit No.	Description	Hrs
1	Introduction to Renewable Energy Overview of global and national energy scenarios, Need for renewable energy and sustainability, Comparison of renewable and non-renewable energy sources, Government policies and incentives for renewable energy adoption.	06
2	Solar Energy Systems Basics of solar radiation and measurement, Photovoltaic (PV) systems: Types, working principles, and efficiency, Solar thermal systems: Collectors, solar water heaters, and solar concentrators, Applications of solar energy: Power generation, desalination, and space heating, solar energy prediction models.	06
3	Wind Energy Systems Fundamentals of wind energy and wind power generation, Wind turbine types, aerodynamics, and power extraction, Wind farm planning, site selection, and grid integration, Challenges and advancements in wind energy technology, efficiency, wind energy prediction models.	06

4	Biomass and Bioenergy Biomass resources and their classification, Conversion technologies: Combustion, gasification, and biogas production, Biofuels: Biodiesel, bioethanol, and their applications, Waste-to-energy technologies and environmental benefits.	06
5	Hydropower and Geothermal Energy Principles of hydroelectric power generation, Classification of hydro plants: Small, medium, and large-scale hydropower, Geothermal energy sources and power generation techniques, Direct-use applications of geothermal energy.	06
6	Emerging Renewable Technologies and Energy Storage Ocean energy: Tidal, wave, and ocean thermal energy conversion (OTEC), Hydrogen as a renewable fuel: Production, storage, and fuel cells, Energy storage technologies: Batteries, flywheels, and pumped hydro storage, compressed air, Smart grids and future trends in renewable energy integration.	06

References –

Text Books:

1. Rai G. D. Non-Conventional Energy Sources, Khanna Publishers.
2. Boyle G. Renewable Energy: Power for a Sustainable Future, Oxford University Press.
3. Sukhatme, S. P., Nayak, J. K. – Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill.

Reference Books:

1. Twidell, J., Weir, T. – Renewable Energy Resources, Taylor & Francis
2. Duffie, J. A., Beckman, W. A. – Solar Engineering of Thermal Processes, Wiley
3. Godfrey, B. – Wind Energy Handbook, Wiley
4. Sorensen, B. – Renewable Energy: Physics, Engineering, Environmental Impacts, Economics & Planning.

Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code: OE363	Course Name: Robotics Engineering & Applications	3	-	-	3

Course Description:

This course explores the practical applications of robotics in various industries, including manufacturing, healthcare, agriculture, defense, and space exploration. It provides an understanding of robotic systems, sensors, actuators, and AI-driven automation. Students will learn about industrial robots, service robots, autonomous systems, and emerging trends in robotics. The course emphasizes real-world case studies, ethical considerations, and the impact of robotics on society, preparing students for careers in robotics and automation.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain various applications of robotics in industry and society.
- CO2. Describe the concept of automation, robot integration, and their role in Industry 4.0.
- CO3. Investigate the use of robots in healthcare, agriculture, defence, service, and space exploration.
- CO4. Discuss ethical considerations and future trends in robotics applications.

Prerequisite: Basics of Mechanical Engineering, Basics of Robotics and automation, sensors and Actuators, Control System

Course Content		
Unit No.	Description	Hrs
1	Robotics in Agriculture Introduction, historical development, Autonomous tractors, drones, and harvesting robots, impact and sustainability of agricultural robots, artificial intelligence and machine learning in agricultural robotics	6
2	Industrial Robotics and Manufacturing Applications Use of robots in manufacturing and assembly lines, Robotics in material handling, welding, painting, and packaging, Integration of robots with CNC machines and flexible manufacturing systems (FMS), Industry 4.0 and smart factories: Role of IoT, AI, and digital twins.	6
3	Robotics in Healthcare and Medical Applications Robotics in surgery, rehabilitation, and prosthetics, Assistive robots for elderly and disabled individuals, Role of AI in robotic healthcare applications, Case studies on robotic-assisted surgery (e.g., Da Vinci Surgical System).	6
4	Robotics in Défense, and Space Exploration Military robots: Unmanned ground vehicles (UGVs), aerial drones (UAVs), and bomb disposal robots, Robotics in space exploration: Rovers, robotic arms, and satellite servicing, Challenges and advancements in space robotics.	6

5	Service, Autonomous, and Humanoid Robotics Service robots: Household, hospitality, and customer service applications, Autonomous robots: Self-driving cars, warehouse automation, and logistics, Humanoid robots and their interaction with humans, Ethical concerns and the impact of robotics on employment, Case Study of Humanoid Robots (Rashmi, Sofiya, Yashnee etc)	6
6	Future Trends, Challenges, and Ethical Considerations Soft robotics and bio-inspired robots, AI and machine learning in robotics, cybersecurity risks and ethical considerations in robotics applications, robo grammer and robo romi, Future challenges and opportunities in robotics engineering.	6

References –

Text Books:

1. Spong, M. W., Hutchinson, S., Vidyasagar, M. – Robot Modeling and Control, Wiley
2. Mukherjee, S. – Robotics and Automation Engineering, Oxford University Press
3. Mittal, R. K., Nagrath, I. J. – Robotics and Control, Tata McGraw-Hill
4. Rajput, R. K. – Robotics and Industrial Automation, S. Chand Publishing

Reference Books:

1. Groover, M. P. – Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill.
2. Siciliano, B., Khatib, O. – Springer Handbook of Robotics, Springer.
3. Craig, J. J. – Introduction to Robotics: Mechanics and Control, Pearson.

Class: - T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code: OE353	Course Name: Factory Automation	3	-	--	3

Course Description:

To provide a clear view on factory automation types & to learn the various methods involved in automatic control and monitoring & to familiarize with factory automation systems in manufacturing and process industry.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Recognize various automation technologies in manufacturing and process industries.
- CO2. Select various automation tools and methods in the manufacturing industry.
- CO3. Implement various control and automation methods in process industries.
- CO4. Analyze automation systems for manufacturing and process industries.

Prerequisite:

Manufacturing systems, sensors and actuators,

Course Content

Unit No	Description	Hrs
1.	Introduction: Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines.	06
2.	Material Handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.	06
3.	Automated Manufacturing Systems: Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies.	06
4.	Control Technologies in Automation: Industrial Control Systems, Process Industries versus Discrete Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms	06
5.	Computer Based Industrial Control: Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog & Digital I/O Modules, SCADA Systems& RTU. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems	06
6.	Case Study: Factory automation in manufacturing industry and Process Industry.	06

References -

Reference Books:

- Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover, Pearson Education.
 - Computer Based Industrial Control- Krishna Kant, EEE-PHI, 2nd edition, 2010
 - An Introduction to Automated Process Planning Systems- Tiess Chiu Chang & Richard A. Wysk
1. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi.
 2. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, ISA Publication.
 3. Bolton, "Programmable Logic Controllers" Newnes.

Class: - T.Y. B. Tech	Semester- V		L	T	P	Credits
Course Code: OE355	Course Name: Cyber Physical Systems		3	--	--	3

Course Description: To study the basic concepts, requirements, principles, and techniques in emerging cyber-physical systems. Provide students hands-on experience in prototyping a cyber-physical system. Address real-world problems through Cyber Physical Systems. The objective of this course is to develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective. The course also aims to provide students of different disciplinary background with necessary knowledge to understand the fundamentals of cyber physical systems

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Understand the need and purpose of the different components of CPS
2. Design physical system depends on its requirements
3. Develop the ability to interact with cyber-physical systems protocols
4. Analyze common methods used to secure cyber-physical systems

Prerequisite: -NA-

Course Content		
Unit No	Description	Hrs
1.	Computational foundation of Cyber Physical Systems: Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, Industry 4.0, IIoT. Introduction Toward Industry 5.0: Cognitive Cyber-Physical System	06
2.	Cyber Physical System Design: Cyber Physical Systems Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems.	06
3.	Cyber Physical System Platforms & Models: Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems.	06
4.	Cyber Physical System – Models and Dynamics Behaviors: Continuous Dynamics, Discrete dynamics, Hybrid Systems	06
5.	Concurrent Models of computation: Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation	06
6.	Security and Privacy in Cyber Physical Systems: Security and Privacy Issues in CPSs, Cyber Security Laws in India: IT Act(2000), IPC(1980), Companies Act (2013), Local Network Security for CPSs, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cyber security in Digital Manufacturing/Industry 4.0	06

References -

Text Books:

1. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015
2. E. A. Lee, Sanjit Seshia, "Introduction to Embedded Systems – A Cyber-Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2

Reference Books:

1. Guido Dartmann, Houbing song, Anke schmeink, "Big data analytics for Cyber Physical System", Elsevier, 2019
2. Houbing song, Danda B Rawat, Sabina Jeschke, Christian Brecher, "Cyber Physical Systems Foundations, Principles and Applications", Elsevier, 2017
3. Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019
4. Houbing Song, Glenn A.Fink, Sabina Jesche, "Security and Privacy in Cyber-Physical Systems: Foundations, Principles and Solutions", IEEE Press.

Class: - T. Y. B. Tech	Semester-V
Course Code: OE357	Course Name: Internet of Things

L	T	P	Credits
3	-	-	3

Course Description:

The Internet of Things (IoT) course explores the interconnected world of smart devices, enabling students to grasp the fundamentals of IoT architecture, protocols, and applications. Through hands-on projects, students develop skills in device integration and data management. The course equips learners with a comprehensive understanding of IoT's transformative potential, preparing them to navigate the evolving landscape of connected technologies and contribute to the advancement of the digital era.

Course Learning Outcomes:

After completion of this course, students will be able to:

- CO1. Explain the concepts of network connected embedded devices.
- CO2. Identify and summarize different components required for IOT applications.
- CO3. Analyse the system through Data Analytics tools.
- CO4. Design suitable network architecture and use appropriate protocols for a given IOT application.

Prerequisite: Basic knowledge of microprocessor and microcontroller, communication

Course Content		
Unit No.	Description	Hrs
1.	Introduction & Basic of IoT: Definition, Characteristics, Physical and Logical Designs, IOT enabling technologies, IoT levels and deployment templates. Major Components of IoT System	06
2.	M2M and IOT management: Introduction, M2M comparison with IOT, M2M architecture, software and development tools IOT management, communication technologies, communication protocols, Web connectivity tools.	06
3.	IoT platform design methodology: Design methodology, IoT Device, IoT Platform Design Specification, Building blocks, Hardware and board approach, Useful Softwares and packages	06
4.	IOT data storage and Cloud: Data generation, local data storage and Purpose of Cloud, clouds used in IoT application, Cloud Storage Models, Communication APIs	06
5.	Iot Security: Vulnerabilities, security requirements, Threat analysis, IoT Security Tomography, Layered Attacker Model, Identity Management, Establishment, Access Control Secure Message Communication, Security Models	06



K. E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Syllabus for B.Tech. Robotics & Automation
To be Implemented for 2024-28 NEP Batch
Department of Robotics & Automation

6.	Domain specific IOT: Home automation, Cities, Environment, Agriculture, Health and lifestyle.	06
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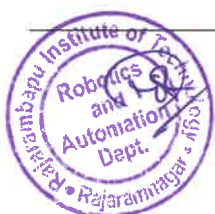
References-

Text Books:

1. Arshdeep Bahga, Vijay Madisetti., "Internet of Things – A hands On Approach," 1st Edition, Universities Press.
2. Raj Kamal, "INTERNET OF THINGS -Architecture and Design Principles" McGraw Hill.

Reference Books:

1. Simone Cirani, " Internet of Things- Architectures, Protocols and Standards", WILEY, 2018.
2. Alessandro Bassi, " Enabling Things to Talk- Designing IoT solutions with the IoT Architectural Reference Model", Springer.



Class: - T. Y. B. Tech	Semester-V	L	T	P	Credits
Course Code: OE359	Course Name: Drone Technology	3	-	-	3

Course Description:

This course explores the revolutionary and riveting research in the ultramodern domain of drone technologies, drone-enabled applications. It explains the most recent developments in the field, challenges, and future scope of drone technologies. Beyond that, it discusses the importance of a wide range of design applications, drone/ Unmanned Aerial Vehicle (UAV) development.

Course Learning Outcomes:

After completion of this course, students will be able to:

- CO1. Elaborate drone technology.
- CO2. Explain fundamentals and design principles of UAV.
- CO3. Discuss the wide range of applications of drone.
- CO4. Classify various propulsion and controlling techniques for drone.

Prerequisite: Basic knowledge of electronics and control.

Course Content		
Unit No.	Description	Hrs
1.	Introduction: Definitions and Terminology, Types of Drone (based on wings), Physical Structure of Drone, Drone System Stack up of mechanical parts, Classification of UAVs, Military and Civilian Unmanned Aircraft	06
2.	UAV Design Principles: Introduction to UAV Design Principles, Computational and Experimental Design of a Fixed-Wing UAV, Payload Design of Small UAVs, Small UAV Design Development and Sizing, Systematic Design Methodology and Construction of Micro Aerial Quadrotor Vehicles.	06
3.	UAV Basic Components: Four basic components: propeller, engine, body, and flight board, Fixed wing drone, main structural elements of drone Kinematics and Dynamics, Dynamics and Control of Flapping Wing MAVs, Principles of Guidance, Navigation, and Control of UAVs.	06
4.	UAV Propulsion: UAV Propulsion: Introduction, Power Managements of a Hybrid Electric Propulsion System Powered by Solar Cells, Fuel Cells, and Batteries for UAVs.	06
5.	UAV Control:	06

	Linear Flight Control Techniques for UAV, Nonlinear Flight Control Techniques for UAV, Adaptive Control of UAV: Theory and Flight Tests, Robust and Adaptive Control Methods for Aerial Vehicles.	
6.	UAV Applications: Drone Usage areas: Agriculture, Environment, Survey of UAVs for Traffic Monitoring, Cooperative Unmanned Aerial Systems for Fire Detection, Barriers to drone Technology: Power Source & Security.	06

References-

Text Books:

1. Kimon P. Valavanis, George J. Vachtsevanos, Handbook of Unmanned Aerial Vehicles, Springer

Reference Books:

1. Neeraj Kumar Singh, Porselvan Muthukrishnan, Industrial System Engineering for Drones, Apress
2. Sachi Nandan Mohanty, J.V.R. Ravindra, Drone Technology: Future Trends and Practical Applications, Wiley

Class:- T.Y. B. Tech	Semester- V	L	T	P	Credits
Course Code: OE351	Course Name: Hydrogen and Fuel Cell Technology	3	--	--	3

Course Description:

The course is a learning about hydrogen and fuel cells – the cornerstones of hydrogen and fuel cell energy. The focus is on understanding the main driving forces of global changes and earning the basic knowledge of the key technologies leading to alternative energy source.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Choose proper energy storage systems hydrogen and applications
- CO2. Explain the different types of fuel cell technologies, fuels and membrane used in it
- CO3. Design and Compare performance of fuel cell.

Prerequisite:

Engineering Chemistry, Fluid Mechanics, Engineering Thermodynamics, Materials science

Course Content		
Unit No	Description	Hrs
1.	Hydrogen energy: Introduction to hydrogen economy, production, storage and transportation systems, hydrogen from fossil fuels, electrolysis of water, thermo chemical cycles, transmission and infrastructure requirements, safety and environmental impacts, economics of transition to hydrogen systems	06
2.	Hydrogen production: methods, types of electrolyzers: proton-exchange membrane, alkaline, solid oxide, alkaline, microbial, efficiency, open circuit voltage, and losses	06
3.	Hydrogen storage and transportation: Methods of storage, solid, liquid, gaseous, Comparison between various methods, limitations, Transportation features, safety norms, methods, on boards and stationary applications	06
4.	Fuel cells: Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages, different types of fuel cells and applications, characteristics, Nernst equation, relation of the fuel consumption versus current output	06
5.	Membranes & Fuels for Fuel Cells: Membranes: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments.	06

	Fuels: Hydrogen, methane, methanol – Sources and preparation, reformation processes for hydrogen – clean up and storage of the fuels – use in cells, advantages and disadvantages of using hydrogen as fuel.	
6.	Fuel cell design and performance: Stoichiometric coefficients and utilization percentages of fuels and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and serial connection, over-potential and polarizations, DMFC operation scheme, general issues-water flooding and water management, polarization in PEMFC	06

References: -

Text Books:

- J Larminie, A L Dicks, Fuel Cell Systems Explained, Wiley X Li, Principles of Fuel Cells, Taylor and Francis.
- Dell, Ronald M Rand, David A J, 'Understanding Batteries', Royal Society of Chemistry
- M. AuliceScibioh and B. Viswanathan 'Fuel Cells – principles and applications', University Press, India.

Reference Books:

- F. Barbir, 'PEM fuel cells: theory and practice', Elsevier, Burlington, MA.
- G. Hoogers, 'Fuel cell handbook', CRC, Boca Raton, FL.
- O'Hayre, R.P.S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, N
- Basu,S.(Ed) Fuel Cell Science and Technology, Springer, N.Y.
- Dincer, H Ishaq, Renewable Hydrogen Production, Elsevier.
- G Naterer, I Dincer, C Zamfirescu, Hydrogen Production from Nuclear Energy, Springer.
- B Sorensen, G Spazzafumo, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Academic Press.

Class: Third Year B. Tech. Civil	Semester: V	L	T	P	Credits
Course Code: CEMD301	Course Name: Infrastructure Engineering	3	-	-	3

Course Description:

This course provides an overview of infrastructure planning and design, covering roads, airports, railways, and harbors. Explore the history and present status of India's roads, delve into geometric design principles for highways, and learn about diverse pavement types. Gain insights into airport planning, runway layout, lighting, and markings. Conclude with a broad understanding of railway and harbor engineering for comprehensive insights into infrastructure development.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Apply the knowledge of geometric design in road construction.
- CO2. Identify the quality parameters of pavement materials and various methods of road construction.
- CO3. Discuss the various aspects of airport engineering.
- CO4. Explain design parameters of railway engineering and its component parts.
- CO5. Summarize the different off shore structures for dock and harbors.

Prerequisite: Physics

Course Content

Unit No.	Description	Hrs
01	Highway Planning Introduction: Classification of roads, Brief history of road development in India, Present status of roads in India, NHAI, NHDP, PMGSY, MSRDC; Geometric Design of Highways: Terrain classification, Design speed. Highway cross-section elements, Sight distance, Overtaking sight distance, Intersection sight distance;	06
02	Geometric Design of Roads Design of Horizontal Alignment: Horizontal curves, Design of super elevation and its provision, Radius at horizontal curves, Widening of pavements at horizontal curves, Methods of extra widening; Design of vertical alignment: Different types of gradients, Grade compensation on curves, summit curves, valley curves	06
03	Highway Construction Types of Pavement (Flexible and Rigid); Types of Roads: WBM, WMM, DBM, SDBC, SMA, PQC, DLC; Highway Drainage: Necessity, sub surface and surface drainage; PPP in Transport Sector	06
04	Airport Engineering Introduction: Advantage and limitation of air transportation, Aircraft component parts and characteristics, Important terms in Airport planning,	06

	Airport layout: Imaginary surfaces, Zoning requirements Runway Location and orientation, Runway configuration, Characteristics of good layout, Basic runway length, Use of wind rose diagram. Airport Lighting and Markings.	
05	Railway Engineering: History of Indian Railways; Recent development in railways specifically w.r.t. track structure; Permanent Way; Component parts of railway track; Railway lines classification based on speed; Geometric Design: Alignment, Gradient, Horizontal Curves, Superelevation; Points, Crossing and Turnouts; Signaling and Interlocking: Control of train movements and monitoring, Types of signals, Principal of interlocking; Modernization in Railway and Railway Tracks	06
06	Dock and Harbor Engineering: Introduction, Planning and layout of ports, Classification, Site Selection, Breakwater, Jetties, Locks, Shore protection works.	06

References:

Text Books:

1. Khanna and Justo, "Highway Engineering", Nemchand Bros, Roorkee.
2. L R Kadiyali, "Highway Engineering", Khanna Publisher.
3. S.C. Saxena & S.P. Arora, "A textbook of Railway Engineering", Dhanpat Rai Publications.
4. S. K. Khanna, M. G. Arora, "Airport Planning & Design", Nemchand Bros, Roorkee

Reference Books:

1. Partha Chakraborty and Animesh Das, "Principles of Transportation Engineering", Prentice Hall of India Ltd., New Delhi.
2. Satish Chandra, M. M. Agarwal, "Railway Engineering" Oxford University Press India.

Class: - T. Y. B.Tech	Semester- V	L	T	P	Credits
Course Code: CSMD301	Course Name: Fundamentals of Database Systems	3	-	-	3

Course Description:

A database is an organized collection of data. A relational database, more restrictively, is a collection of schemas, tables, queries, views, and other elements. It defines data models, relational models, constraints that can be used in design of the relational database, also it focuses on file structure, transaction management and recovery of databases. The course also provides an overview of SQL which is used for implementation of relational databases. data. A general-purpose DBMS is a software system designed to allow the definition, creation, querying, update and administration of databases.

Course Learning Outcomes:

After Successful Completion of the course student will be able to,

- CO1.** Describe the fundamental elements of relational database management systems.
- CO2.** Design ER-models to represent simple database application scenarios.
- CO3.** Write SQL query to perform various operations on the database.
- CO4.** Analyze principle of integrity constraints, Hashing and Indexing on databases.
- CO5.** Illustrate the transaction management, concurrency control and crash recovery.

Prerequisite:

A basic understanding of programming concepts (using languages such as JAVA or C++) and foundational knowledge of data structures and algorithms.

Course Content		
Unit No	Description	Hrs
1	Introduction to Database Concepts Purpose of Database Systems, Data abstraction, Data Models, Entities and Entity sets, Mapping Constraints, E-R Diagram, Reducing E-R Diagrams to Tables, Generalization and Aggregation	6
2	Relational Model Structure of Relational Databases, Structured Query Language (SQL): Data Definition Language, Data Manipulation Language, Aggregate functions, Set Operations.	6
3	Integrity Constraints and Database Design Domain Constraints, Referential Integrity, Functional Dependencies, Decomposition, Normalization: 1NF, 2NF, 3NF	6
4	Data Storage and Indexes File Organization, Data Dictionary Storage, Indexing: B+ tree indexing and B tree indexing, Hashing: Static and Dynamic.	6
5	Basic of Transactions Concepts of transaction processing, ACID properties, Transaction states, Serializability, Testing for serializability.	6
6	Concurrency Control and Recovery System Lock-based protocols, Timestamp - based Protocols. Crash Recovery: Failure Classification, Log-Based Recovery, Checkpoints.	6

References –

Text Books:

1. Silberschatz, Henry F. Korth, and S. Sudharshan, “Database System Concepts”, Tata McGraw Hill.
2. J. Date, A. Kannan and S. Swamynathan, “An Introduction to Database Systems”, Pearson Education.

Reference Books:

1. Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”, Pearson/Addison Wesley.

Class:-Third Year B. Tech.	Semester- V
Course Code : EEMD301	Course Name : Electrical Machines

L	T	P	Credits
3	--	--	3

Course Description:

The Electrical Machines minor course is designed to provide students with a fundamental understanding of the principles, operation, and applications of electrical machines in various engineering systems. This course serves as an introduction to the field of electrical machines, covering both theory and practical aspects. Students will gain insights into the performance, and control of electrical machines, which are essential components in modern electrical and electronic systems.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Describe behavior of dc machine.
- CO2. Explain the working principle of 1-Phase and 3-Phase transformers.
- CO3. Explain working of different induction motors.
- CO4. Select the relevant electrical machines for different applications.
- CO5. Interpret the relevant fractional horse power motor for different applications.

Prerequisite:

Basic Electrical Engineering, Engineering mathematics and Engineering physics.

Course Content		
Unit No	Description	Hrs
1	DC Machine Fleming's right hand rule, Construction of dc machine with their parts information, Principle of operation of dc generator and Motor, Fleming's left hand rule, Voltage equations of dc motor, Torque equation of dc motor, Characteristics of dc motors, Speed control methods of dc motor, Applications of dc machine.	06
2	Transformer Construction of 1-Phase and 3-Phase transformer, Principle of operation, EMF equation of transformer, transformation ratio, Types of transformers, Ideal transformer on no load, Practical transformer on no load and on load, Phasor diagram of practical transformer for different loads, Losses in transformer, efficiency of transformer, Applications of transformer.	06
3	Induction Motors 1-Phase Induction motor: Resistance start/Split phase induction motor, Capacitor start induction run motor, Capacitor start capacitor run induction motor 3-Phase Induction motor: Construction and working of 3-Phase Induction motor, Types of 3-Phase Induction motors, Synchronous	06



	speed, rotor speed, Slip, Torque equation of 3-Phase Induction motor, Need and types of starters, Speed Control of 3-Phase Induction motors Applications of induction motors.	
4	Synchronous machines Alternator: Construction and working principle, EMF equation, Types of rotors, Terminal voltage, Armature reaction at various p.f., Voltage regulation Synchronous Motor: Construction and working principle, Different torques in synchronous motor, Effect of excitation, Applications of synchronous machines.	06
5	Fractional Horse Power Motors Permanent Magnet DC Motor (PMDC), Brushless DC Motor (BLDC), Steeper Motors, AC and DC Servo Motor, SRM, Universal motor. Applications of various special purpose motors	06
6	Electric Drives Introduction to controlled rectifiers, Electric Drives, Advantages of Electrical drives, Parts of electrical drives, Choice of electrical drives, Status of ac and dc drives, fundamental torque equations, Multiquadrant operation, Classification of drives	06

References -

Text Books:

1. Ashfaq Husain, Electric Machines, Dhanpat Rai & Co
2. V K Mehta, Principle of Electric Machine, S Chand Publication
3. D.P. Kothari, I Nagrath, Electric Machines, Tata McGraw-Hill Education.

Reference Books:

1. P. S. Bimbhra, Electrical Machinery, Khanna Publishers
2. B.L. Theraja and A.K. Theraja, Electrical Technology, S Chand Publication
3. Charles I. Hubert, Electric Machines: Theory, Operating Applications, and Controls, Pearson publication

Class: - T. Y. B. Tech ETC Engg.	Semester-V		L	T	P	Credits
Course Code : ECMD301	Course Name : Advanced Communication Techniques		3	-	-	3

Course Description:

This course covers the basics of antenna and wave propagation, key antenna parameters, and various antenna types. It includes an overview of 5G communication systems, channel modeling, and the challenges of 5G wireless propagation. Additionally, the course introduces modern communication techniques like fiber optics, GSM, CDMA, LTE, Bluetooth, WiFi, ZigBee, LoRA, and RFID.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Explain the principles of antenna and wave propagation.
- CO2.** Understand basic antenna parameters and their types.
- CO3.** Discuss the evolution, requirements, and challenges of 5G communication systems.
- CO4.** Understand and compare various communication techniques.
- CO5.** Communicate effectively on complex engineering topics related to modern communication techniques.

Prerequisite:

Knowledge of basic analog and digital communication.

Course Content

Unit No	Description	Hrs
1.	Basics of Antenna and Wave Propagation Introduction to Antenna and wave propagation, Types of wave propagation, Wave Polarization, Types of Wave polarization.	06
2.	Antenna Parameters Basic Antenna parameters: Antenna pattern, Half power beam width, Beam area, Radiation intensity, Beam efficiency, Directivity and Gain, Resolution, Front to Back ratio, Effective height, Reflection coefficient, Impedance bandwidth, and pattern bandwidth.	06
3.	Types of Antennas Dipole Antenna, Antenna Array, Wire Antenna, Microstrip Antenna, Aperture antenna, Dish Antenna, Yagi Uda Antenna.	06
4.	Overview of 5G Communication Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G.	06

5.	The 5G wireless Propagation Channels Channel modeling requirements, propagation scenarios, and challenges in the 5G modeling, Channel Models for mm-Wave MIMO Systems.	06
6.	Communication Techniques Fundamentals of Fiber Optics Communication, GSM, CDMA, LTE, Blue Tooth, WiFi, ZigBee, LoRA, RFID.	06

References -

Text Books:

5. Constantine A. Balanis "Antenna Theory: Analysis and Design" Wiley Publication.
6. John D. Kraus and Ronald J. Marhefka "Antennas and Wave Propagation" McGraw-Hill Publication.
7. Theodore S. Rappaport "Wireless Communications: Principles and Practice" Pearson Publication.
8. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.

Reference Books:

1. John D Kraus, Antenna for all Application, TMH publication
2. Louis Frenzel, "Communication Electronics Principles and Applications" TMH Publication.
3. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons

Class:- T.Y. B. Tech	Semester-V
Course Code : CIMD301	Course Name : Introduction to DBMS

L	T	P	Credits
3	--	--	3

Course Description:

A database is an organized collection of data. A relational database, more restrictively, is a collection of schemas, tables, queries, views, and other elements. It defines data models, relational models, constraints that can be used in design of the relational database, also it focuses on file structure, transaction management and recovery of databases. The course also provides an overview of SQL which is used for implementation of relational databases. A general-purpose DBMS is a software system designed to allow the definition, creation, querying, update and administration of databases.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Describe the fundamental elements of relational database management systems.
- CO2.** Design ER-models to represent simple database application scenarios.
- CO3.** Write SQL query to perform various operations on the database.
- CO4.** Analyze principles of integrity constraints, Hashing and Indexing on databases.
- CO5.** Illustrate the transaction management, concurrency control and crash recovery.

Prerequisite: Data Structures

Course Content		
Unit No.	Description	Hrs
1.	Introduction to Database Concepts Purpose of Database Systems, Data abstraction, Data Models, Entities and Entity sets, Mapping Constraints, E-R Diagram, Reducing E-R Diagrams to Tables, Generalization and Aggregation.	06
2.	Relational Model Structure of Relational Databases, the Relational Algebra, the Tuple Relational Calculus, Structured Query Language (SQL), Joins.	06
3.	Integrity Constraints and Database Design Domain Constraints, Referential Integrity, Complex datatypes, Functional Dependencies, Pitfalls in Relational Database Design, Decomposition, Normalization	06
4.	Data Storage and Indexes File Organization, Data Dictionary Storage, Indexing: B+ tree indexing and B tree indexing, Hashing: Static and Dynamic.	06

5.	Query Processing and Basic of Transactions Overview, Query Interpretation, Concepts of transaction processing, ACID properties, Transaction states, Serializability, Testing for serializability.	06
6.	Concurrency Control and Recovery System Lock-based protocols, Timestamp - based Protocols, Multiple Granularities, Deadlock handling, Crash Recovery: Failure Classification, Log-Based Recovery, Checkpoints, Shadow Paging	06

References -

Text Books:

1. Abraham Silberschatz , Hank Korth and S. Sudarshan , “Database System Concepts”, McGraw Hill Education.
2. Ram Krishnan, Johanses Gehrke, “Database Management Systems”, McGraw Hill Education.

Reference Books:

1. J.D. Ullman, “Principles of Database Systems ”, Galgotia Publications.
2. Jio Wiederhold, “Database Design”, McGraw Hill International.

Class: T.Y. B. Tech.	Semester-V		L	T	P	Credits
Course Code: MEMD305	Course Name: Product Design Tools and Techniques		3	--	--	3

Course Description:

This course introduces students to the fundamental and advanced tools and techniques used in product design, focusing on engineering principles, design for manufacturability, value engineering, concurrent engineering, reverse engineering, and prototyping. The course combines theoretical foundations with practical applications, including case studies. These tools and techniques are widely practiced in industry. Exposure to this course will add value to the students and make them industry-ready.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the basic principles of engineering design.
- CO2. Design products for ease of manufacturing and assembly.
- CO3. Apply value engineering and concurrent engineering principles in product design.
- CO4. Apply various prototyping techniques using reverse engineering and rapid prototyping.
- CO5. Analyse the product development economics for a given project.

Unit No	Description	Hrs.
1.	Principles of Engineering Design: Introduction to engineering design, Introductory principles – Iteration, Compromise, Complexity, Responsibility, Simplification., Problem identification, Creativity, Concept selection, Embodiment, Modelling, Detail design, Design management, Information gathering.	06
2.	Design for Manufacturability, Assembly and Sustainability: Overview of DFM and DFA principles, Case studies of DFM and DFA, Techniques and Tools for DFM and DFA, Techniques to simplify manufacturing processes, Tools for assessing and optimizing assembly processes, Environmental Considerations in Manufacturability and Assembly, Introduction to sustainable design and environmental impact, Tools for environmental assessment, including life-cycle analysis.	06
3.	Value Engineering: Introduction, Nature and Measurement of Value, The Value Analysis Job Plan, Steps to Problem-Solving and Value Analysis, Value Analysis Tests, Value Engineering Idea Generation Check-list, Cost Reduction Through Value Engineering, Case Study on Tap Switch Control Assembly, The Methodology, Benefits of Value Engineering, Material and Process Selection in Value Engineering.	06
4.	Concurrent Engineering: Introduction to Concurrent Engineering, Fundamentals of CE, Need and basic principles of CE, Benefits of implementation of CE, Introduction to various	06

	integrating mechanisms, forming of CE team. Teamwork: Interfacing of manufacturing and design, selection of key techniques and methodologies, selection of CE tools.	
5.	Prototyping Techniques: Reverse Engineering: scope and tasks of re, process of duplicating, definition and use of reverse engineering, reverse engineering as a generic process, cognitive approach to re, integration of formal and structured methods in reverse engineering. Modern Prototyping Techniques: traditional prototyping methods, additive manufacturing (3d printing), subtractive manufacturing (cnc machining), rapid prototyping applications. am process chain, classification of am processes, design for am, post processing.	06
6.	Product Development Economics: Product development cash flow, NPV, economic analysis base -case model, sensitivity analysis and it's use for determining trade-off.	06

References: -

Text books: -

1. Engineering Design Principles, Kenneth S. Hurst, Butterworth-Heinemann.
2. Kathryn, A. Ingle, Reverse Engineering, McGraw-Hill.
3. Product Design for Manufacture and Assembly, G. Boothroyd, CRC Press Inc.
4. Product Design and Manufacturing, A.K. Chitale and R.C. Gupta, PHI Learning Private Limited, Delhi.
5. Chua Chee Kai, Leong Kah Fai, Rapid Prototyping: Principles & Applications, World Scientific.

Reference Books:

1. Linda Wills, Reverse Engineering, Kluiver Academic Publishers.
2. Larry W. Zimmerman, Glen D. HartVan Nostrand Reinhold, Value Engineering: A Practical Approach for Owners, Designers, and Contractors, SAVE International.

Class: - T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code: MCMD301	Course Name: Sensor and Instrumentation	3	-	--	3

Course Description:

This course provides an in-depth understanding of sensors and instrumentation used in mechatronics systems. Students will learn the principles of various sensors and their applications in measuring physical quantities. The course will cover topics such as sensor types, signal conditioning, data acquisition, and integration of sensors into mechatronics systems with real life applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the fundamental principles of various sensors and transducers.
- CO2. Analyze the characteristics, advantages, and limitations of different sensor types.
- CO3. Select and integrate sensors into mechatronic systems for real-time data acquisition and control.
- CO4. Apply appropriate signal conditioning techniques to improve sensor output accuracy.
- CO5. Develop mechatronic systems using appropriate sensors for real-life applications.

Prerequisite:

1. Basic knowledge of mechatronics systems.
2. Familiarity with electronics and electrical circuits.

Course Content

Unit No	Description	Hrs
1	Introduction to Mechatronics and Sensors: Definition and scope of mechatronics, Role of sensors in mechatronic systems, Classification of sensors based on transduction principles, Sensor Characteristics and Performance Parameters such as sensitivity, accuracy, precision, resolution, hysteresis, etc., Calibration and compensation techniques.	06
2	Temperature Sensors:	06

	Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared (IR) temperature sensors. Position and Displacement Sensors: Potentiometers, LVDT (Linear Variable Differential Transformer), Optical encoders, Inductive sensors.	
3	Force and Pressure Sensors: Strain gauges, Load cells, Pressure transducers, Piezoelectric, Piezoresistive, and Capacitive Pressure Sensors, Ultrasonic Sensors Motion and Velocity Sensors: Accelerometers, Gyroscopes, Proximity sensors, Hall Effect Sensors.	06
4	Light and Imaging Sensors: Photodiodes, Phototransistors, Image sensors (CMOS, CCD) Wireless and IoT Sensors: Bluetooth, Wi-Fi, Zigbee, and other wireless protocols, Integration of sensors into IoT platforms.	06
5	Sensor Interfacing and Signal Conditioning: Amplification and filtering, Analog-to-Digital Conversion (ADC), Sensor interfaces, Noise reduction and error compensation Data Acquisition and Processing: Sampling theorem and Nyquist frequency, Data acquisition systems (DAQ) Analog and digital signal processing, Sensor fusion techniques	06
6	Case Studies and Real-World Applications: Robotics and automation systems, Autonomous vehicles, Biomedical applications, Health care, defense applications, agricultural applications, automobile sector, communication devices, home security.	06

References -

Textbooks:

1. Principle of Industrial Instrumentation by D. Patranabis, Tata McGraw Hill, 2nd Ed.
2. Instrumentation and Measurement Principles by . D.V.S. Murty, PHI, New Delhi, 2nd Ed.
3. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney,
4. Dhanpat Rai & Co, 2nd Ed.
5. Process control instrumentation technology by Curtis D. Johnson, PHI learning Pvt. Ltd, 07th Ed

Reference Books:

1. Measurement Systems by E.O. Doebelin, McGraw Hill, 06th Ed.
2. Process Measurement & Analysis by B.G. Liptak, CRC press, 04th Ed.
3. Instrumentation Devices and Systems by C. S. Rangan, G. R. Sharma and V. S. Mani,
4. Tata McGraw-Hill Publishing Company Ltd., New Delhi, 02nd Ed.
5. Mechanical and Industrial Measurements by R. K. Jain, Khanna Publishers, 02nd Ed.



Class: T. Y. B. Tech.	Semester- V	L	T	P	Credits
Course Code: AIMD301	Course Name: Machine Learning	3	-	-	3

Course Description:

The students will understand the basics of Machine Learning. They will learn to apply different machine-learning algorithms to various datasets.

Course Learning Outcomes:

After successful completion of the course, students will be able to:

- CO1. Utilize machine learning techniques and understand the basic theory underlying machine learning.
- CO2. Articulate supervised, unsupervised and reinforcement learning.
- CO3. Identify the basic concepts of learning and decision trees.
- CO4. Utilize Bayesian techniques for problems appear in machine learning.
- CO5. Perform statistical analysis of machine learning techniques.

Prerequisites:

- Basic knowledge of Probability theory and python programming.

Course Content		
Unit No	Description	Hrs
1	Introduction Learning in the context of ML, three phases of performing ML, Algorithms and Models in ML, Logical, Geometric and Probabilistic models, Underfitting, Overfitting and Right models, Practical ML examples, Types of ML problems, Classification of ML algorithms.	06
2	Decision Trees Purpose and uses, Constructing a decision tree, Gini Index, Gain ratio, ID3, C4.5, CART, Benefits of decision tree, Random Forest.	06
3	Regression-Based Learning Regression Analysis, Covariance, Correlation Coefficient, Regression Methods, Simple liner regression, Regression Model, Multiple Regression, Polynomial regression, Generalized linear models, Logistic regression.	06
4	Instance Based Learning and kernel-methods based learning KNN algorithm, Determining K, distance measures in KNN, Case based	06

	Reasoning, Support vector Machines (SVM).	
5	Clustering Based Learning Types of clustering, K-means clustering algorithm, Advantages and disadvantages of K-means clustering, Distance measures.	06
6	Bayesian learning Classical, Empirical, Subjective methods, Types of events, Types of probabilities, Normal Distribution, Bayes' Theorem, Naïve Bayes' classifier.	06

References

Text Books:

1. Sunila Gollapudi "Practical Machine Learning" PACKT Publishing.
2. Mitchell, Tom. M., "Machine Learning", McGraw-Hill Education.
3. John Paul Mueller and Luca Mueller, "Machine Learning for Dummies".

Reference Books:

1. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Tylor and Francis Publication.

Class: T.Y B. Tech.	Semester: V
Course Code: RAMD301	Course Name: Kinematic & Dynamics for Robots

L	T	P	Credits
3	-	--	3

Course Description:

This course provides a comprehensive introduction to the fundamental principles of robot kinematics and dynamics. Students will explore the mathematical models used to describe the motion of robotic systems, including both the kinematic and dynamic analysis required for designing and controlling robots. The kinematics portion of the course covers topics such as position, velocity, and acceleration in robotic systems, forward and inverse kinematics, and workspace analysis. Students will gain an understanding of how to model and control the motion of robotic arms, mobile robots, and other autonomous systems. The dynamics section delves into the forces and torques that cause robots to move, introducing Newton-Euler and Lagrangian formulations for modeling the dynamics of robotic manipulators and mobile platforms.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Represent object using composite rotation matrix.
- CO2. Apply spatial transformation to obtain forward and inverse kinematics.
- CO3. Plan trajectories for the robot end effector.
- CO4. Perform Jacobian analysis of serial manipulators.
- CO5. Perform dynamic analysis using different robot formations

Prerequisite: Kinematics of Machines, Dynamics of Machines

Course Content

Unit No.	Description	Hrs
1.	Fundamental Concepts Robot Joints, Workspace analysis, work envelope of robots, Robot Coordinates, Robot Reference Frames, Frame Transformation, Translational Operator, Rotational Operator, Composite Rotation Matrix, Representation of Orientation using Roll, Pitch, Yaw angles and Euler Angles.	06
2.	Forward Kinematics Denavit-Hartenberg notations, link- joint parameter, D-H rules for coordinate assignment, Arm Equation, Forward kinematics of manipulators, Screw transformation	06
3.	Inverse Kinematics Decoupling technique, Inverse transformation Technique, Inverse kinematic analysis of robot with standard configurations, methods for solution of non-linear simultaneous equations, singularity.	06
4.	Jacobian Analysis of Serial Manipulators Different Kinematics of rigid body, Different Kinematics of serial manipulators, screw coordinates and screw systems, Manipulator Jacobian	06

	Matrix, conventional Jacobian, Screw-Based Jacobian, and Transformations of screw coordinates. Relationship Between Two Methods, condition number, singularity analysis.	
5.	Trajectory Planning Introduction, Constraints and Path specifications, polynomial function, linear trajectory Function, Basic algorithm for generation of joint trajectory, joint interpolated trajectories, Cartesian path trajectory planning.	06
6.	Robot arm Dynamics & Parallel Robot Dynamics: Robot dynamics – Rigid body dynamics, Newton-Euler formation, Lagrange-Euler, formation, generalized D'Alembert equations of motion, Dynamic Analysis: Two mass statically and dynamically equivalent system, correction couple, static and dynamic force analysis of reciprocating engine mechanisms, Crank shaft torque, Introduction computer aided analysis.	06

References:

Text Book-

1. D. K. Pratihar, Fundamentals of Robotics, Narosa Publication.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Publishers, 2008
3. Reza N Jazar, Theory of Applied Robotics, Kinematics, Dynamics and Control, Spriger, Second Edition

Reference Books-

1. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.
2. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering: An Integrated Approach, PHI Learning., 2009.
3. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
4. Bernard Hodges, Industrial Robotics, Second Edition, Jaico Publishing house, 1993.
5. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press., 2003.
6. Hartenberg and Denavit, "Kinematics and Synthesis of Linkages", McGraw Hill Book Co.
7. J. E. Shigley and J.J.Uicker Jr., Theory of Machines and Mechanism, McGraw Hill
8. Kelly R, Santibanez V and Loria A, —Control of Robot Manipulators in Joint Space, Springer, 2005.

Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code: RA323	Course Name: Programmable Logic Controllers and SCADA	2	-	0	2

Course Description:

This course offers an in-depth exploration of Programmable Logic Controllers (PLCs) and Supervisory Control and Data Acquisition (SCADA) systems, which are essential components of industrial automation. Students will gain a solid understanding of PLC programming, operation, and integration with industrial processes. The course covers the key concepts behind PLC hardware, ladder logic programming, input/output modules, and communication protocols. It also introduces SCADA systems, focusing on their role in monitoring and controlling industrial operations through graphical user interfaces and real-time data acquisition.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explore the architecture and components in PLC.
- CO2. Demonstrate proficiency in Ladder logic programming and troubleshooting.
- CO3. Explain SCADA system fundamentals, design, and implementation.
- CO4. Summarize Distributed Control System and its applications.

Prerequisite: Basic of electronics, sensors and actuators.

Course Content		
Unit No.	Description	Hrs
1	Programmable Logic Controllers Introduction - Parts of PLC - Principles of operation - PLC sizes - PLC hardware components - I/O section - Analog I/O modules - digital I/O modules CPU processor memory module - PLC programming Simple instructions - Output control devices - Latching relays PLC ladder diagram.	04
2	PLC Programming and Ladder Diagram Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters, program control instructions - Data manipulation instructions-math instructions	04
3	Application Of PLC Traffic light control, 24-hour clock design, Automatic stacking process, temperature control, Automatic control of warehouse door, Automatic lubrication of supplier Conveyor belt, motor control.	04
4	Networking Of PLC and SCADA Networking of PLCs-Data Communication-Fieldbus, PROFI bus, and Mod bus-OSI Model types-OPC function. Supervisory Control and Data Acquisition-Architecture-Remote terminal unit-Master terminal unit-Data Storage	04

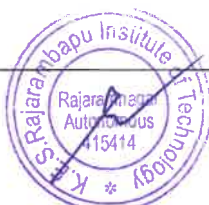
5	Distributed Control System Evolution - Architectures - Comparison - Local control unit - Process interfacing issues - Communication facilities. Operator interfaces - Low level and high-level operator interfaces - Operator displays - Engineering interfaces - Low level and high-level engineering interface	04
6	Case Studies of PLC-DCS-SCADA Pulp and paper environment -Power plant - Petroleum - Refining environment, Wireless control system in challenging environments like welding shops, Introduction to Soft PLC.	04

References –

1. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Lucas M.P., Distributed Control System, Van Nostrand Reinhold Co. NY.

Text Books:

1. Webb, John W., Programmable Logic Controllers: Principles and Application, Prentice Hall of India, New Delhi.
2. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, ISA Publication.



Class: Third Year	Semester: V		L	T	P	Credits
Course Code: CEMD303	Course Name: Smart Cities & Sustainable Development		2	-	-	2

Course Description:

This course will introduce students to the concepts of smart cities and different ideologies of smart cities and sustainable development. Different approaches of different countries all over the world toward smart cities and sustainable development will be studied and evaluated. The current smart city mission in India its plans and provisions and different aspects will also be studied and critically evaluated. Measurement of sustainability and its assessing framework will also be studied under this course. Present condition of sustainability in India its needs, issues and challenges will also be studied

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Discuss the concept of smart cities and ideologies of sustainable Development.
- CO2. Analyze the different approaches toward smart cities on global level.
- CO3. Evaluate the present state and approach of Smart city Mission in India.
- CO4. Comprehend the concept of resilience and sustainable development and its measurement.
- CO5. Study the present status of sustainable development in India.

Prerequisite: Basics of civil engineering

Course Content		
Unit No.	Description	Hrs
01	Introduction Smart cities concept, origin, ideology. Typologies and different meanings, Wired city, Virtual city, Intelligent city, Information city, Digital city. Characteristics of smart cities: smart economy, smart people, smart governance, smart mobility, smart environment, smart living Strategies and policies.	04
02	Critical evaluation of Smart City Concept	04

	Approaches towards smart cities in various countries. Smart city planning in advanced economies, economic, financial viability, social implications. Financial and economic viability of smart city. Critical evaluation of smart city development projects in India	
03	Smart City Mission in India Smart city mission: Objectives, features, coverage and duration. Preconditions and criteria for the selection of smart city, actions and tools for smart cities Strategies, retrofitting, redevelopment, Greenfield, Brownfield, pan-city. Governance and management special purpose vehicles.	04
04	Resilience and Sustainable Development Sustainable Development Introduction, Origin, Definition, three pillars of Sustainable Development, Critiques on Sustainable Development. The concept of resilience: need and significance in the contemporary time, city preparedness, adaptations, risk reduction and mitigation. Climate change and resilience.	04
05	Measurement of Resilience and Sustainability. The Theory and Measurement of Sustainability: Ideologies and Ethos of Sustainability, Indicators, Indicator Framework for Assessing Sustainability, Measurement Systems for Sustainable Urban Development: Concept Level (Broad) Measurement Systems,	04
06	Sustainability in India Sustainability in India: Need, Issues and Challenges, Urbanization in India, Sustainable Development in India, Sustainability Measurement and Rating Systems and Initiatives in India	04

References:

Text Books:

1. Sharma P. and Rajput S., "Sustainable Smart Cities in India", Springer International Publishing.
2. Srinivasan R., Sookoor T., Jeschke S., "Smart Cities: Foundations, Principles, and Applications", John Wiley Publishing.

Reference Books:

1. Mora L., Deakin M., "Untangling Smart Cities", Elsevier Science.
2. Dag R. Bennett, Diana Pérez-Bustamante Yábar, "Sustainable Smart Cities", Springer International Publishing.
3. Ministry of Environment and Forests, "Sustainable Development in India: Stocktaking in the run up to Rio+20", Government of India.



Class:-T.Y. B. Tech	Semester-V		L	T	P	Credits
Course Code: CSMD303	Course Name: Object-oriented Programming in Python		1	--	2	2

Course Description:

This course is designed to introduce students to the Python programming language, providing a solid foundation in its syntax, principles, and applications. Through hands-on coding exercises and projects, students will gain practical experience, enabling them to apply Python to various programming tasks and problem-solving scenarios. The course emphasizes good coding practices, algorithmic thinking, and an understanding of key programming concepts.

Course Learning Outcomes:

After successful completion of the course, students will be able to:

- CO1.** Demonstrate a comprehensive understanding of Python syntax, data types, and basic operations.
- CO2.** Make use of common Python libraries for data manipulation.
- CO3.** Implement lists, tuples, sets, and dictionaries for effective data handling.
- CO4.** Apply principles of OOP, including classes, objects, inheritance, and polymorphism.

Prerequisite:

Basic understanding of programming concepts.

Course Content		
Unit No.	Description	Hrs.
01.	Introduction to Python fundamentals: Python introduction, Python syntax, Python comments, Python variables, Python data types, Python numbers, Python casting, Python strings, Python Booleans, Python operators, Loops and Conditional Statement If-else, while, for, lambda, arrays, Python Iterators, Python scope	02

02.	Lists, Tuples, Sets, Dictionaries: Access, change, add and remove list elements, loop lists, list comprehension, list methods, access, update, unpack tuples, loop tuples, tuple methods, Access, add, remove set items, set methods, access, add, change, remove dictionary items, nested dictionaries, dictionary methods.	02
03.	Classes and Objects: Classes, objects, parameterized and non-parameterized init constructor, object methods, self-parameter, association, Access modifiers: Private, public, protected	02
04.	OOP Concepts: Inheritance, Encapsulation, Polymorphism: overloading and overriding, abstraction: interface and abstract class	02
05.	File handling and Exception: File handling syntax, read files, write/create files, delete files, handling runtime exception and custom exception.	02
06.	Modules and Libraries Introduction, modules, using dir() function, Numpy, Pandas, Matplotlib, Seaborn, markers, line, labels, grid, subplots, scatter, bars, histograms, pie-charts	02

It should consist of minimum 10 experiments based on the syllabus and experiment list mentioned below.

Course Content		
Expt. No	Description	Hrs
1.	Write Python programs using variables, data types, operators, input/output statements, type casting, and comments.	02
2.	Implement programs using if-else, nested if, while loop, for loop, break, continue, and pass statements.	02
3.	Perform string operations, slicing, string methods, user-defined functions, lambda functions, and scope of variables.	02
4.	Create and manipulate lists, tuples, sets, and dictionaries using various built-in methods and comprehensions.	

5.	Implement iterators, iterable objects, and perform operations on arrays.	02
6.	Create classes and objects using constructors, object methods, and self parameter.	02
7.	Demonstrate public, private, and protected members along with association between classes.	02
8.	Implement single, multilevel inheritance, method overriding, and method overloading concepts.	02
9.	Develop programs using abstract classes, interfaces, encapsulation, and data hiding techniques.	02
10.	Perform file read/write/create/delete operations and implement runtime and custom exception handling.	02
11.	Create user-defined modules, use dir() function, and perform array operations using NumPy.	02
12.	Perform data manipulation using Pandas and create plots such as line chart, bar chart, histogram, scatter plot, pie chart, and subplots using Matplotlib/Seaborn.	02

References -

Text Books:

1. "Python Programming: A Modular approach" by Sheetal Taneja, Naveen Kumar
2. "Python Programming: Using Problem Solving Approach" by Reema Thareja

Reference Books:

1. "Learning Python: by Mark Lutz
2. "The Complete Reference: Python" by Martin C. Brown



Class:- T.Y. B. Tech.	Semester-V		L	T	P	Credits
Course Code : EEMD305	Course Name: Electrical Technology		1	-	2	2

Course Description:

This laboratory course emphasis on imparting the practical knowledge and understanding of basic principles, characteristic, performance and testing of electrical systems. In this lab course, students will be familiar with the use of different electrical equipment and safety precautions on work place.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Demonstrate speed control methods of electrical machines.
- CO2. Analyze performance of DC motor and induction motor for speed control applications.
- CO3. Implement power electronic circuits for given application.
- CO4. Measure electrical quantities using electrical and electronic instruments.

Prerequisite: Basic Electrical Engineering, Basic Electronics Engineering

Course Content		
Unit No	Description	Hrs
1	Power Electronic Devices: Power diode, BJT, Thyristor, MOSFET, IGBT: Structure, Symbol, Working Principle, Comparison.	02
2	Power Electronic Circuits: Rectifier: single phase full wave diode rectifier, Chopper: basic step-down and step-up Chopper, Inverter: single phase full bridge inverter.	02
3	Electrical and Electronic Measurements: Electrical instruments, characteristics of measuring instruments, standards of measurement, voltmeter, ammeter and wattmeter, digital multi-meter, power analyzer. Comparison of analog and digital meters.	02
4	Transducers: Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Measurement of weight, speed, temperature, pressure and flow.	02
5	Solar and Wind Energy Systems: Solar cell fundamentals, V-I characteristics of a PV panel, principles of wind energy conversion, components of wind energy conversion system, classification of wind turbines- horizontal axis and vertical axis. Wind power integration into grid-power system , grid connected PV systems	02

6	Electric Vehicle: What Is an Electric Vehicle? Engineering philosophy of EV development, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle, Overview of EV Technologies.	02
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Expt. No.	Description	Hrs
1	Study of different starters of DC Motors.	2
2	Perform speed control of DC Shunt Motor by Armature Voltage and Field Current Control Method.	2
3	Perform polarity test on single-phase Transformer.	2
4	Perform speed control of an Induction Motor.	2
5	Measurement of active & reactive power for three phase supply.	2
6	Measurement of Electrical parameters by Power Analyzer.	2
7	Study of Single-Phase Full Wave Rectifier	2
8	Study the effect of wind speed on wind power generation.	2
9	Plot I-V and P-V characteristics of PV modules.	2
10	Study of Electric Vehicle and Battery Management System.	2

Note- Perform any Ten Experiments.

References -

Text Books:

4. Ashfaq Husain, Electric Machines, Dhanpat Rai & Co
5. V K Mehta, Principle of Electric Machine, S Chand Publication

Reference Books:

4. P. S. Bimbhra , Electrical Machinery, Khanna Publishers
5. B.L.Theraja and A.K.Theraja, Electrical Technology, S Chand Publication

Class: - T. Y. B. Tech ETC Engg.	Semester-V		L	T	P	Credits
Course Code: ECMD303	Course Name: Electronic Product Design		2	-	-	2

Course Description:

This course aims to introduce various methods, processes and protocols in product design. In this course student will develop a strong fundamental base for the design of electronic product.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Elaborate product design processes.
- CO2. Explain various aspects of PCB design.
- CO3. Differentiate product-testing methods.
- CO4. Create various documents for the product.

Prerequisite:

Knowledge of basics analog and digital electronics and communication.

Course Content

Unit No	Description	Hrs
1.	Product Design and Development Introduction, Product Development Basics, Product Development Stages, Identification of the Customer Requirements, Techno-Commercial Feasibility of a Product, Pilot Production Batch, Product Assessment, Availability, Screening Test of Component, Redundancy, Ergonomic and Aesthetic Design Considerations	04
2.	Noise and Heat Management Power Supply Protection Devices, Transient Voltage Suppressor, Fuses, Line Filters, Noise Consideration of a Typical System, Noise in Electronic Circuits, Grounding, Shielding, Guarding. Thermal Management.	04
3.	PCB Design Introduction to PCBs, Layout, Issues Related to PCB Size, Design Issues Related to Supply and Ground Conductors, Multilayer Boards, Component Assembly Techniques, Comparison of PCBs.	04
4.	Hardware and software Design and Testing Methods Introduction, Signal Integrity, Software Design and Testing Methods, Phases of Software Design, Selection of Language for Software Development, Assemblers, Compilers, Simulators, Emulators.	04
5.	Electronic Product Testing	04

	Introduction, Environmental Testing, Temperature Testing, Thermal Modeling of Components, Humidity Testing, Electrical Overstress Testing, Altitude Testing, Special Testing, Environmental Test Chambers and Rooms, Various Tests on Enclosures, EMI and EMC Related Testing, Importance of Standards, List of Some Standards.	
6.	Product Documentation Introduction, Types of Documentation, How to Prepare an Effective Document, PCB Documentation, Bill of Material: A Documentation of Part List, Manual Types.	04

References -

Text Books:

1. R.G.Kaduskar, V.B.Baru, Electronic Product Design, Wiley Publication

Reference Books:

1. Walter C Bosshart, Printed Circuit Board design and technology, Tata McGraw Hill
2. Clyde Coombs ,Handbook of Printed Circuit, MCGraw Hill publication
3. M.G. Loveday, Electronic testing and fault diagnosis, Longman publication

Class:- T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code : CIMD303	Course Name : OOP using Java	1	--	2	2

Course Description:

Object Oriented Programming is pillar of software development. The strong knowledge of object-oriented programming helps to create the better software. The main aim of this course is to cover the object-oriented concepts with java programming language. This course lets students to write computer programs using Java Development Kit and using the principles of Object-Oriented paradigm. The course covers Object-Oriented concepts, Java classes, array, exception handling, string API in Java. Students will develop desktop applications by using object-oriented concepts with use of Java Standard Edition. This course is also useful for learning the advanced java courses such as JSP, Servlet, Struts, and spring frameworks.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Explain the concepts and terminologies in object-oriented concepts and java programming language.
- CO2.** Apply object-oriented programming features and concepts for solving given problem.
- CO3.** Develop the java application using the collection framework to solve real word problem.
- CO4.** Apply the concepts exception handling to develop error free codes.
- CO5.** Utilize the concepts of package to develop efficient codes.

Prerequisite: Basic knowledge of C Programming

Course Content

Unit No	Description	Hrs
1.	Introduction to Java Programming Java buzzwords, Features of Java, JDK, JRE and JVM, Variables and data types, I/O statements in Java, Conditional and looping statements, Arrays.	02
2.	Introduction to Object-Oriented Programming Features of object-oriented programming, Class and objects, Constructors, Method and constructor overloading, Nested classes.	02
3.	Features of Object-Oriented Programming Polymorphism: Method overloading (Compile time Polymorphism), Method overriding (Run time Polymorphism), Inheritance, super, this, static and final keywords, Abstraction, Interface, Garbage collection.	02
4.	Collection and String Collection, Collection Framework, List: ArrayList, LinkedList, Vector and Stack, Queue: Deque and Priority Queue, Set: TreeSet and HashSet, Map: Hash Table and Hash Map, Java String.	02

5.	Exception Handling Exceptions & Errors, Types of Exception, Control Flow in Exceptions, JVM reaction to Exceptions, Exception keyword. In-built and User Defined Exceptions, Checked and Un-Checked Exceptions.	02
6.	Packages Organizing Classes and Interfaces in Packages, Package as Access Protection Defining Package, CLASSPATH Setting for Packages, Naming Convention for Packages.	02

Course Content		
Experiment No.	Description	Hrs.
1	Introduction to Java Programming	02
2	Classes, Object, and Method	04
3	Constructor	02
4	Inheritance	02
5	Method overloading and method overriding	02
6	Interface	02
7	Nested classes and abstract classes	02
8	Collection frameworks	04
9	Exception handling	02
10	Packages	02

References –

Text Books:

1. M.T. Somashekara, D.S. Guru, K.S. Manjunatha, "Object Oriented Programming with Java", Kindle Edition, PHI Publication.
2. Rajkumar Dr. Buyya, "Object Oriented Programming with Java: Essentials and Applications".
3. Dr. Ms. Manisha Bharambe, Ms. Manisha Gadekar, "OBJECT ORIENTED PROGRAMMING USING JAVA I", Kindle Edition, Nirali Publication.

Reference Books:

1. Deitel and Deitel, "Java How to Program", Prentice Hall, Seventh Edition.
2. Niemeyer & Leuck, "Learning Java", O'REILLY (SPD), Fourth Edition.

Class: - T.Y. B. Tech.	Semester- V		L	T	P	Credits
Course Code: MEMD307	Course Name: Design and Prototyping		1	--	2	3

Course Description:

This course provides students with practical experience in computer-aided design (CAD), focusing on sketching, part design, and the simulation and execution of additive manufacturing processes. Students will engage in hands-on activities that culminate in the 3D printing of their designed components.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Use CAD software to create detailed CAD models and designs.
- CO2. Explain the workflow and settings for effective additive manufacturing.
- CO3. Simulate the 3D printing process to identify and correct potential issues before actual printing.
- CO4. Print a 3D component based on CAD models.

Prerequisites:

Basic knowledge of engineering, drawing and design principles

Course Content

Unit No	Description	Hrs.
1.	Introduction to CAD and Sketcher Basics: Overview of CAD software, Basic operations and navigation, creating simple sketches and applying dimensions.	04
2.	Advanced Sketching Techniques: Using geometric constraints, Parametric sketching techniques, Practice exercises on complex shapes.	04
3.	Basic Part Design: Extruding and revolving sketches, Introduction to editing features like fillets, chamfers, and shells.	04
4.	Advanced Part Design: Applying advanced features and reference geometries, Transformation feature-Patterning, Scaling, Mirror, Creating assemblies from multiple parts.	04
5.	Introduction to Simulation in Additive Manufacturing: Basic principles of simulation for 3D printing, Setting up a simulation from a CAD model.	04
6.	Simulation for Material Optimization and Strength: Using simulation to predict material usage and optimize print parameters, analyzing results and making adjustments.	06

7.	Preparing for 3D Printing: Converting CAD models to printable files (slicing), Selection of materials, Hands-on setup and initialization of 3D printers, sample 3D Printing of Components, Techniques for cleaning and finishing 3D printed parts.	04
8.	Project - 3D Printing of Components: Selection of component, CAD design, simulation, 3D printing of designed parts, Post-Processing and Evaluation of Printed Components.	06

References:

Text books

1. Engineering Design and Graphics with SolidWorks by James D. Bethune
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing by Ian Gibson, David Rosen, and Brent Stucker.

Reference Books:

1. The 3D Printing Handbook: Technologies, design and applications" by Ben Redwood, Filemon Schöffner, and Brian Garret.

Class: - T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code: MCMD303	Course Name: Industrial Automation	2	-	--	2

Course Description:

To provide a clear view on Programmable Logic Controllers (PLC) & to learn the various methods involved in automatic control and monitoring & to familiarize with the communication protocol this course has been inducted.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explore the architecture of PLC and its functions.
- CO2. Execute the various instructions and logic in PLC.
- CO3. Develop the PLC program for various applications.
- CO4. Design and develop the SCADA, DCS system for various applications.

Prerequisite:

Knowledge of fundamentals of Mechatronics

Course Content

Unit No	Description	Hrs
1.	PROGRAMMABLE LOGIC CONTROLLERS Introduction - Parts of PLC - Principles of operation - PLC sizes - PLC hardware components - I/O section - Analog I/O modules - digital I/O modules CPU processor memory module - PLC programming Simple instructions - Output control devices - Latching relays PLC ladder diagram,	04
2.	INSTRUCTIONS Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters.	04
3.	APPLICATION OF PLC Traffic light control, 24-hour clock design, Automatic stacking process, temperature control, Automatic control of warehouse door,	04

4.	NETWORKING OF PLC AND SCADA Networking of PLCs-Data Communication-Fieldbus, PROFI bus, and Mod bus-OSI. Supervisory Control and Data Acquisition-Architecture.	04
5.	DISTRIBUTED CONTROL SYSTEM Architectures - Comparison - Local control unit, Operator interfaces - Low level and high-level operator interfaces - - Low level and high-level engineering interface	04
6.	APPLICATIONS OF DCS Pulp and paper environment -Power plant - Petroleum - Refining environment, Wireless control system in challenging environments like welding shops, Introduction to Soft PLC.	04

References -

1. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Lucas, M.P., Distributed Control System, Van Nonstrandreinhold Co. NY.
3. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, ISA Publication. Bolton, "Programmable Logic Controllers" Newnes.

Class: T. Y. B. Tech.	Semester- V		L	T	P	Credits
Course Code: AIMD303	Course Name: Business Intelligence		2	-	-	2

Course Description:

This course is very useful as it aims in applying statistical techniques for analyzing data to help managerial people make informed decisions. It covers data preprocessing, modeling and visualization tasks thoroughly to give insight into the life cycle of a BI task. It makes students explore various analysis techniques which are also studied in various advanced data management related courses.

Course Learning Outcomes:

After successful completion of the course, students will be able to.

- CO1. Articulate data pre-processing techniques.
- CO2. Analyze the data modeling required for business intelligence related tasks.
- CO3. Determine the role of statistical techniques in data analysis tasks.
- CO4. Identify big data analysis techniques.
- CO5. Utilize different reporting/visualization tool.

Prerequisites:

1. Database Management Systems.
2. Basic Probability and Statistics.

Course Content		
Unit No	Description	Hrs
1	Introduction What is business intelligence (BI)? Need for BI. Drawing insights from data: DIKW pyramid, levels of decision making (strategic, tactical and operational BI). Examples of business analyses–funnel analysis, distribution channel analysis and performance analysis.	05
2	Data Preprocessing Notion of data quality. Typical preprocessing operations: combining values into one, handling incomplete/ incorrect / missing values, recoding values, sub setting, sorting, transforming scale, determining percentiles, removing noise, removing inconsistency, transformations, standardizing, normalizing - min-max normalization, score standardization.	04

3	Inferential Statistics Role of probability in analytics, probability distributions and their characteristics. Need for sampling, generating samples, sampling and non-sampling error. Sampling Distribution of Mean, Central Limit Theorem, Standard Error. Estimation: Point and Interval Estimates, Confidence Intervals, level of confidence, sample size.	04
4	Data Warehousing What is a data warehouse, need for a data warehouse, architecture, data marts, OLTP vs OLAP, Multidimensional Modeling: Star and snow flake schema, Data cubes, OLAP operations, Data Cube Computation and Data Generalization, Data Lake.	04
5	Enterprise Reporting Metrics, Measurement, Measures, KPIs, Dashboards, Reports, Scorecards.	03
6	Hypothesis Testing Basic concepts, Errors in hypothesis testing, Power of test, Level of significance, p-value, general procedure for hypothesis testing. Parametric and non-parametric tests – z test, t test, chi-square test. Two tailed and one-tailed tests. Chi-square test for independence and goodness of fit. ANOVA.	04

References

Text Books

1. James R Evans, "Business Analytics", Pearson.
2. Jiawei Han and Micheline Kamber, Morgan Kaufman, "Data Mining: Concepts and Techniques", ISBN 978- 81-312-0535-8.
3. R. N. Prasad, Seema Acharya, "Fundamentals of Business Analytics", ISBN: 978-81- 256-3203-2, Wiley-India – Types of Digital Data, OLTP-OLAP, Introduction to BI, data integration.
4. Business Analytics for managers, Wolfgang Jank–exploring and discovering, Data Modeling.

Reference Books:

1. Ken Black, "Applied Business Statistics: Making Better Business Decisions (English)", Wiley India.
2. Rob JHyndman, George Athanasopoulos, Otext, "Forecasting: Principles and Practices",



Class: T. Y. B. Tech.	Semester: V	L	T	P	Credits
Course Code: RAMD305	Course: Robot Programming	1	--	2	2

Course Description:

This course provides a comprehensive introduction to robot programming techniques and control strategies. Students will learn how to program robots to perform various tasks autonomously and interact with their environment using robot operating system.

This course covers Robot programming fundamentals, motion planning and control, Robot simulation and testing.

Course Outcomes:

After the successful completion of this course, the student should be able to:

- CO1. Explain Robot programming ecosystem.
- CO2. Create reusable code for robot powered applications.
- CO3. Design a custom robot using programming.
- CO4. Simulate and control the robot using ROS.

Prerequisite: Knowledge in C++ and/or Python Programming language. Linux, Robot kinematics and Dynamics.

Course Content		
Unit No	Description	Hrs
1.	Introduction Robot Programming: Methods of robot programming. Categories of Robot programming languages. Robot programming Language Structure. Functions in Robot programming Language.	03
2.	Robot Operating System (ROS): Introduction of ROS. Benefits of ROS. ROS history. Features of ROS. ROS applications. ROS1 and ROS2 comparison. ROS functionalities, ROS structure, Distribution, Tools, Architecture, Philosophy.	03
3.	Robot Operating System (ROS): ROS workspace, Nodes, Packages, Topics. The ROS Graph. ROS interface, Service	03
4.	Block-based coding Working of block-based coding, features of block-based coding, designing interface, block-based coding with robots. Block based programming languages.	03

List of experiments (Any 10)

Course Content		
Expt. No.	Description	Hrs.
1.	Introduction to Robot Programming (ROS).	02
2.	ROS Nodes, Topics, Services, Parameters, Launch Files	02
3.	ROS Workspace and ROS Package.	02



4.	Unified Robotic Description Format (URDF) for robot	02
5.	Links, Joints, Collisions, Inertia tags in the URDF file	02
6.	Launch file to Start the Robot State Publisher with URDF (XML)	02
7.	XML using Python launch files	02
8.	Make the URDF Compatible with Xacro.	02
9.	Functions with Xacro Macros.	02
10.	Motion in ROS.	02
11.	Computer vision in ROS with open CV	02
12.	Connecting Hardware with ROS	02

References Books:

1. Robot Operating System for Absolute Beginners by Lentin Joseph
2. Programming Robots with ROS Morgan Quigley, Brian Gerkey, and William D. Smart.
3. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice-Hall.
4. S. K. Saha, Introduction to robotics, The McGraw Hill Company.
5. K.S. Fu; Gonzalez, R.C. & Lee, C.S.G, Robotics-Control, Sensing, Vision and Intelligence, McGraw Hill.

Class:-Third Year	Semester- V	L	T	P	Credits
B. Tech.					
Course Code : RA331	Course Name : Mini Project - I	-	-	6	3

Course Description:

This course provides students with an opportunity to integrate the concepts acquired from the foundational courses of the first four semesters through the design, development and validation of an engineering artefact. The project emphasizes systematic engineering design, analytical modelling, engineering calculations, experimentation, testing, validation and debugging. Students are expected to justify their design decisions using engineering principles, analyse the performance of the developed system through experimental evidence, and communicate their engineering work through professional documentation and presentations. The course develops engineering thinking, teamwork, project management, technical communication and lifelong learning skills, while laying a strong foundation for advanced project work.

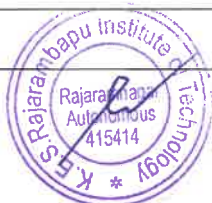
Course Learning Outcomes:

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

- CO1. Identify a suitable engineering problem that requires integration of knowledge from multiple foundational courses
- CO2. Apply theories, principles, tools and methods to design and analyze engineering problem.
- CO3. Use modern tools such as CAD, programming environments, simulation tools and testing instruments to solve engineering problem
- CO4. Work effectively in teams, take responsibilities and develop decision making skills to become effective and creative leaders.
- CO5. Test, validate and improve the developed solution using appropriate performance indicators
- CO6. Communicate the project work through oral presentation, demonstration and technical report.

Prerequisite: Engineering Mechanics, Strength of Materials, Materials and Manufacturing Technology, Fundamentals of Robotics and Automation, Robot Kinematics, Analog and Digital Electronics, Sensors and Instrumentation, Electric Drives and Control, Control Systems

Course Activities		
Wee No	Description	Hrs
1	Course orientation, team formation, selection of project theme, identification of foundational courses, problem definition.	06
2	Requirement analysis, Foundation Integration Map, system architecture, project planning.	06



3	Engineering design, block diagrams, design calculations, component selection, Review-I (Theme Approval).	06
4	Detailed design, modelling/simulation, subsystem development.	06
5	Prototype development, module testing, documentation, Review-II (Design & Architecture).	06
6	Completion of subsystem implementation, testing and debugging.	06
7	System integration, performance measurement, validation against design calculations, Review-III (Implementation).	06
8	Performance improvement, error analysis, debugging, documentation.	06
9	Final integration, experimental validation, preparation of technical report, Review-IV (Integration & Validation).	06
10	Completion of technical report, Foundation Integration Map, presentation preparation.	06
11	Mock presentation, demonstration, viva preparation, incorporation of suggestions.	06
12	Final demonstration, report submission, presentation, individual viva-voce and Final Review .	06

Class: T.Y. B.Tech.	Semester- V	L	T	P	Credits
Course Code: RA313	Course Name: PLC & SCADA Lab.	-	-	2	1

Course Description:

This lab provides hands-on experience with Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) systems, essential for industrial automation. Students will learn to program PLCs, design ladder logic, and integrate SCADA for real-time monitoring and control of industrial processes. The lab covers hardware interfacing, troubleshooting, and communication protocols like Modbus and Ethernet. By the end of the course, students will be proficient in developing automated solutions for various industrial applications.

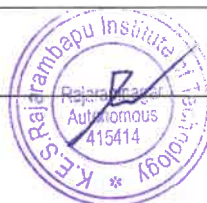
Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Develop the PLC program for the implementation of logic gates.
- CO2. Design to Configure and Interface PLC, SCADA and HMI Systems for real-time monitoring and control.
- CO3. Practice troubleshooting of PLC and SCADA to resolve faults in Automation Systems.
- CO4. Design and implement automation solutions using HMI, SCADA programme for various applications

Prerequisite: Fundamentals of Robotics and Mechatronics, Sensors and Actuators.

Course Content		
Unit No.	Description	Hrs.
1	Introduction to PLC hardware, I/O modules, and ladder logic programming.	02
2	Implement logical operations such as AND, OR, and NOT logic gates using RS logic software	02
3	Design a timer-based system to use PLC timers (ON delay, OFF delay) and counters (up/down).	02
4	Demonstrate a conveyor belt system with sensors and actuators for object sorting.	02
5	Design and demonstrate an automatic water level control system using PLC.	02
6	Implement a traffic light control system using PLC programming.	02
7	Demonstrate the staircase lightning system using PLC	02
8	Introduction to SCADA system components and basic HMI design.	02
9	Interface SCADA with sensors to monitor parameters like temperature and pressure.	02



10	Demonstrate any one HMI and SCADA programming.	02
11	Choose the special I/O for speed control of the DC motor using PLC.	02

Note- Perform any Ten Experiments.

References –

Text Books:

1. Petruzella Frank D., Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
2. Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi.

Reference Books:

1. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, ISA Publication.
2. Bolton, "Programmable Logic Controllers" Newnes .



Class: - T.Y. B. Tech.	Semester-VII
Course Code: RA327	Course Name: Industrial Automation Lab.

L	T	P	Credits
-	-	2	2

Course Description:

The Industrial Automation Laboratory focuses on hands-on training in digital twin technology, PLC/SCADA-based control systems, and DCS architecture used in modern industries. Students design, implement, and test industrial automation applications such as pneumatic actuation systems, tank level control, conveyor systems, pump automation, mixing processes, and temperature control systems. The lab emphasizes system integration, I/O configuration, monitoring, and alarm management to develop practical skills aligned with real-world industrial practices.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Develop Digital Twin models for pneumatic actuators and automated sequence control system.
- CO2. Design SCADA-based industrial control applications.
- CO3. Develop DCS-based industrial control systems with I/O configuration, monitoring, and alarm management.

Prerequisite: PLC programming

Course Content (Lab)

Experiment No	Description	Hrs
1.	Introduction to digital twin technology and platform	02
2.	Digital twin of single acting cylinder	02
3.	Digital twin of double acting cylinder	02
4.	Digital twin of automated sequence and process control	02
5.	Single Tank Filling and Draining Control (SCADA)	02
6.	Conveyor Belt with Object Detection and Counter (SCADA/PLC)	02
7.	Dual Pump Alternate Operation for a Sump Pit (SCADA)	02
8.	Chemical Mixing Process with Two Ingredient Tanks (SCADA)	02

9.	Boiler Temperature Control with High-Temp Trip (SCADA)	02
10.	Introduction to DCS Architecture and Components	02
11.	Interfacing Field Devices with DCS	02
12.	Analog and Digital I/O Configuration and Testing	02
13.	SCADA-HMI Integration with DCS	02
14.	Alarm Management and Event Handling	02
15.	Case Study	02

Note- Perform any Ten Experiments.

References –

Text Books:

1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice-Hall.
2. M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley.

Reference Books:

1. Webb, John W. Programmable Logic Controllers: Principles and Application, Prentice Hall of India, New Delhi.
2. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Class: - Third Year B. Tech.	Semester- VI
Course Code: RA327	Course Name: Engineering Analysis Lab

L	T	P	Credits
-	-	2	1

Course Description:

This laboratory course introduces students to the fundamental principles of Finite Element Analysis (FEA) from the ground up, using industry-standard software (Ansys). Designed for students with no prior theoretical background in FEA or FEM, the course starts with the basic building blocks of simulation—nodes, elements, meshing, and boundary conditions—before progressing to simulate structural behaviors. A key emphasis is placed on Verification and Validation (V&V)—comparing software results with classical mechanics (hand) calculations to build intuition, ensure accuracy, and understand the limitations of computational modelling.

Course Learning Outcomes:

After completion of this course students will be able to,

- CO1. Develop/ select appropriate model required for Analysis
- CO2. Apply proper constraints and boundary conditions
- CO3. Select suitable solver settings of Analysis software.
- CO4. Apply different post processing techniques to interpret the results.
- CO5. Apply optimization tools from Analysis software.

Prerequisite:

Mechanics of Materials (Strength of Materials), CAD Fundamentals

Course Content		
Experiment No	Description	Hrs
1	1D Analysis	2
2	Solid Modelling and Geometry Cleanup	2
3	2D Meshing Methods / Techniques, Mesh Quality and Convergence Test	2
4	3D Meshing Methods / Techniques, Mesh Quality and Convergence Test	2
5	Static Structural Analysis	2
6	Buckling Analysis	2
7	Modal Analysis	2
8	Nonlinear Analysis	2
9	Multibody Dynamic Simulation	2

10	Topology and Topography Optimization	2
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Note- Perform any Ten Experiments.

References -

Text Books:

1. Moaveni, S. *Finite Element Analysis: Theory and Application with ANSYS*. Pearson

Reference Books:

1. Gilat, A., & Subramaniam, V. *Numerical Methods for Engineers and Scientists*. Wiley.

Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code: RA319	Course Name: Summer Internship	-	-	-	2

Course Description:

This course gives opportunity to work in industry or get certification of advanced software which develop skills required for Robotics and Automation domain. Apart from technical knowledge, he/she can explore interpersonal skills as well as ability to learn independently and handle tools & equipment. This course brings awareness about systematic and logical report writing and presentation of the technical efforts. The students can complete the certification on any software (Minimum 30 Hrs.) instead of industrial training.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Gain hands-on experience with industry tools, technologies, and processes to bridge the gap between theoretical learning and real-world applications.
- CO2. Develop professional competency by enhancing problem-solving ability and communication skills.
- CO3. Improve employability through real-world project/industry experience.

Course Content:

- Every student must undergo Two weeks training in industry (internship) after the end of fourth semester.
- A mentor from the faculties will be allotted to every student. Mentors will visit the industry for progress tracking during the training.
- Students must fill a Daily Work Report every day & need to submit all the reports to respective faculty allotted.
- Students have to prepare a report on Industrial Training using a given format.
- After submission of the certificate, the student has to give a presentation in front of students and faculty.
- Assessment will be made on learning outcomes, presentation, knowledge addition, and confidence.
- Every student has to submit the certificate of completion in the first week of starting of fifth semester; after that, no submission will be done and it will be assumed that the student has not undergone industrial training and no credit will be awarded.
- Students must follow rules & regulations of their respective workshop & maintain utmost discipline during the training
- Students should wear apron & safety shoes during the training period.
- Students are expected to extend their learnings by referring to online resources, books, magazines, etc.

OR

Guidelines for certification of software tool:

1. Students can complete the certification course on any software like Solid works, RoboDk, Python etc.
2. The duration of training should be minimum 30 Hrs and should complete any mini-project based on learning.
3. After submission of the certificate, students must give a presentation in front of students and faculty.
4. Assessment will be made on learning outcomes, presentation, knowledge addition, and confidence.

Class: T.Y. B.Tech.	Semester-V	L	T	P	Credits
Course Code: RA329	Course Name: Massive Open Online Course (MOOC)	-	-	-	1

Course Description:

Online courses offered through platforms like NPTEL, SWAYAM, and NASSCOM provide opportunities to deepen students' understanding of advanced robotics and automation concepts and emerging technologies in Robotics and Automation. These courses focus on critical domains such as robot programming, robotic process automation, artificial intelligence and machine learning etc. They blend theoretical foundations with practical applications, enabling students to strengthen problem-solving skills, engage with modern tools, and prepare for industry-oriented challenges, enabling life-long learning. The objective of this course is to emphasize the development of skills and attitudes that enable continuous learning & adaption to new situations.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain advanced principles, methods, and technologies in various areas of robotics and automation
- CO2. Analyze the problems in the domain of robotics and automation using mathematical and engineering fundamentals.
- CO3. Design solutions for robotics and automation systems using modern engineering tools and platforms.
- CO4. Write a robot program to design an automation system for industrial and real life applications.
- CO5. Demonstrate the ability to engage in independent and self-directed learning

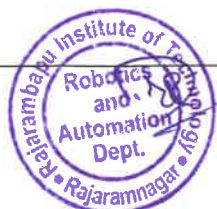
Note:

1. Student will get the credits of respective course in following conditions,
 In case of course selected from NPTEL/SWAYAM/NASSCOM platforms, students have to complete the timely assignments, pass the exam and secure the certificate.
2. While selecting online course, following points must be taken care of,
 - a. Selected course must be approved by Departmental Programme Committee (DPC).
 - b. Duration of each online course must be of at least FOUR weeks for NPTEL/SWAYAM & minimum 12 to 20 hours for NASSCOM.



References-

1. NPTEL (National Programme on Technology Enhanced Learning)
<https://nptel.ac.in>
2. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds)
<https://swayam.gov.in>
3. MOOCs on NASSCOM
www.nasscom.in



Class: - T.Y. B. Tech	Semester-V	L	T	P	Credits
Course Code: SH3035	Course Name: Scholastic Aptitude-I	1	-	2	Audit

Course Description:

Quantitative and Reasoning tests form a major part of most of the competitive exams and recruitment processes. They evaluate numerical ability and problem-solving skills of candidates. Along with the arithmetic abilities, the candidate's patience while reading through the question is also tested. Decision making is also a crucial part of the process with a question having multiple solutions and the candidate has to choose the most efficient one. Fast calculations have become an integral part of a candidate's career. Calculating the remuneration and efficiency, estimating profits and interests on the principal, using a logical approach towards solving a problem is now a routine affair for a professional.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Develop a thorough conceptual understanding and develop a logical approach towards solving Aptitude and Reasoning problems.
- CO2. Understand usage of basic aptitude terms of percentages, averages, ratios and applications of business aptitude terms of profits and interests
- CO3. Develop a bridge in analogies, series and visualizing directions.
- CO4. Apply various short cuts & techniques to manage speed and accuracy to get equipped for various competitive and campus recruitment exams.

Course Content		
Unit No.	Description	Hrs
1	Number System, HCF, LCM Basics, Base System, Exponents, LCM and HCF, Factors, Cyclicity, Different Methods to find LCM-HCF, HCF-LCM relation, Applications of HCF –LCM	03
2	Percentage Understand Conversion, Single change, Successive change, Product Stability, Applications of percentage.	03
3	Average, Allegations Weighted average, Concept of average speed & allegation, Applications of Average & mixture allegation.	03
4	Ratio & Proportion Comparison of Ratio & fraction, Properties of Ratio & Proportion, Mean Proportion Joint ratio.	03
5	Profit & Loss Same selling price different Cost Price, Same cost price different selling price Concept of false scale.	03
6	Simple interest -Compound interest Basics, Difference between SI CI, Conversion Periods, Depreciation.	03

7	TRW, Pipes & Cisterns Time, Rate and Work-Unitary Method, LCM Method, Calculation of remuneration. Pipes & Cisterns -Concept of negative work, LCM Method.	03
8	Blood Relations Blood Relations -Symbols, generation of tree diagram, types of questions-pointing towards person, tree based, coded blood relation.	03
9	Numerical Analogy Basics, Relation between two numbers, numerical	03
10	Pattern, Step Completion Image completion, Mirror images, Water images, input-Output	03
11	Series Completion Types of series, Number series pattern, Letter series, Alphanumeric series,	03
12	Direction Sense Basics, shadow-based concept, Concept of local time zone (IST,GMT, Longitude, Latitude), Problems on local time difference, Coded direction sense	03
13	Coding Decoding Letter-Letter, Letter- Number, Number-Number, Letter-Symbol, Mixed Coding	03
14	Syllogism Basics, Types of Statements, Different diagram for different statements, Types of Questions-Based on Conclusion, Based on Statements	03
Total Hrs.		42

*1 Extra lecture will be conducted.

References –

Reference Books:

1. R. S. Aggarwal, "Quantitative Aptitude", S Chand Publishing, New Delhi.
2. R. S. Aggarwal, "Logical Reasoning", S Chand Publishing, New Delhi.
3. Arun Sharma, "Quantitative Aptitude", McGraw Hill Publishing, New Delhi 7th Edition.
4. Arun Sharma, "Logical Reasoning", McGraw Hill Publishing, New Delhi 3rd Edition.

Class: T.Y. B.Tech.	Semester- VI	L	T	P	Credits
Course Code: RA302	Course Name: Microcontrollers and Embedded systems	3	-	-	3

Course Description:

This course covers PIC microcontroller architecture, instruction sets, I/O programming, and Embedded C programming. It explores the PIC18 family, memory, registers, and directives. Topics include ARM architecture, embedded system design, optimization techniques, and efficient assembly code. Students will learn data handling, programming structures, and performance enhancement for embedded applications.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Analyze the PIC Microcontroller Architecture and Features
- CO2. Apply Instruction Set and I/O Port Programming for PIC Microcontrollers
- CO3. Analyze Embedded C Programming for PIC Microcontrollers
- CO4. Evaluate Embedded System Concepts and ARM Architecture
- CO5. Create and Optimize Embedded C and Assembly Code

Prerequisite: Basic Knowledge of Electronics, Programming Fundamentals, Understanding of Computer Architecture and Logic

Course Content

Unit No.	Description	Hrs
1 PIC Microcontrollers	History, Features and Architecture Microcontrollers, Overview of the PIC18 family, PIC18 PIN function, PIC18 Configuration Registers, SFR, PIC18 File Register and access Bank. Data and program memory, Stack and stack pointer, Status Register, PIC18 Data Format and Directives.	06
2 Classification of Instructions & I/O Port Programming	Addressing modes, Data transfer, Arithmetic Instruction, Logical, Compare, Rotate Instruction and Data Serialization, BCD and ASCII Conversion. Branch, Instructions and Looping, CALL and RET Instructions with programming, timers, ADCs/DACs, UARTs, and interrupts.	06
3 Concepts of Programming	I/O Port structure, Concepts of C Programming, Data types, Conditional statements & loops, arrays and string operations, rotate, bit manipulation, logical operation, functions, use of pointer, Embedded C programs for PIC microcontroller.	06
4 Introduction To Embedded System and Arm Architecture	Challenges of Embedded Systems, Embedded system design process, Embedded processors – ARM processor – Architecture, ARM and Thumb Instruction sets.	06

5	Embedded C Programming C-looping structures, Register allocation, Function calls, Pointer aliasing, structure arrangement, bit fields – unaligned data and endianness, inline functions and inline assembly, portability issues.	06
6	Optimizing Assembly Code Profiling and cycle counting, instruction scheduling, register allocation, conditional execution, looping constructs, bit manipulation, efficient switches, optimized primitives.	06

References –

Text Books:

1. Jonathan W. Valvano, Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers, CreateSpace Independent Publishing Platform
2. John Iovine, The PIC Microcontroller: Your Personal Introduction, McGraw-Hill Education
3. Michael J. Pont, Embedded C Programming and the Atmel AVR, Elsevier

Reference Books:

1. Martin P. Bates, *PIC Microcontrollers: An Introduction to Microelectronics*, Newnes.
2. Jonathan W. Valvano, Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, CreateSpace Independent Publishing Platform
3. Martin P. Bates, *Programming and Interfacing PIC Microcontrollers*, Newnes.

Class: - T.Y. B. Tech	Semester-VI	L	T	P	Credits
Course Code: RA304	Course Name: Research Methodology	2	-	--	2

Course Description: This course is designed to help students develop the research skills required to competently undertake and complete research projects. It will provide students with the training required to develop the skills to review and critically analyze literature on topics related to their research projects, justify the rationale for research, develop effective research designs for their projects, understand the role of theories in research, and learn to write research proposals. Students will acquire skills in both qualitative and quantitative research techniques and learn to report research findings (empirical work) with implications and draw conclusions.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Select on the literature in the field, analyze and interpret research evidence published on a topic to establish a suitable research problem/issue or opportunity to explore further.
- CO2. Design the research study using a suitable paradigm, associated methodologies and methods of data collection and analysis.
- CO3. Write a research proposal (research blueprint) describing the topic.
- CO4. Demonstrate the ability to use the statistical software to solve problems.

Prerequisite:

Basic knowledge of statistics.

Course Content		
Unit No	Description	Hrs
1.	Overview of research Definition of research and characteristics of research; Types of research. A group discussion on what is research.	02
2.	Literature survey Importance of literature review, types of literature review, selection of the review topic, searching for the literature, analyzing and synthesizing the literature, writing the review report.	05
3.	Data Analysis using Statistical tools for analysis Analysis of variance, regression analysis, Response surface methods for process optimization, SPSS/MINTAB/Design Expert software, modeling skills.	05
4.	Creativity in Research , report preparation with Latex and white smoke, Group discussion on Ethics in Research, Plagiarism check.	02
5.	Design of experiments Strategy of experimentation, Statistical design of experiments, replication, randomization and blocking. Guidelines for designing experiments, Factorial	05

	designs. Factorial designs. The two-factor factorial design, Statistical analysis of factorial design, Taguchi design.	
6. Intellectual Property	Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents; their definition; granting; infringement; searching & filing; Utility Models an introduction; Copyrights; their definition; granting; infringement; searching & filing, Trademarks, role in commerce, importance, protection, registration; domain names; Department specific research discussions.	05

References -

Textbooks:

1. Kothari C.K. (2004) 2/e, Research Methodology – Methods and Techniques (New Age International, New Delhi).

Reference Books:

1. Krishnswamy, K.N., Shivkumar, Appa Iyer and Mathiranjana M., Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
2. Gupta, Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.
3. Douglas C. Montgomery, Design and analysis of experiments, John Wiley and Sons, New York.
4. Tapan Bagchi, Taguchi Methods Explained: Practical steps to robust design, Prentice Hall.
5. Phillip J. Ross, Taguchi Techniques for quality engineering, TATA McGraw Hill
6. Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India Ltd, 2006
7. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

Class: - T.Y. B. Tech	Semester-VI	L	T	P	Credits
Course Code: RA306	Course Name: Fundamentals of Micro-Electro- Mechanical Systems (MEMS)	3	-	--	3

Course Description:

This course introduces students to the interdisciplinary field of Microelectromechanical Systems (MEMS), focusing on the design, fabrication, and application of miniature sensors and actuators that form the backbone of modern robotic and automated systems. Students will explore key concepts such as microfabrication techniques, materials selection, mechanical and electrical modeling, and microsystem integration. With growing adoption of MEMS in sectors like robotics, automotive systems, consumer electronics, aerospace, and biomedical devices, this course equips future engineers with industry-relevant knowledge to design and apply MEMS-based solutions. Emphasis is placed on real-world applications such as inertial sensors, pressure transducers, and micro-actuators that drive automation and intelligent decision-making in advanced systems.

Course Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the fundamentals of MEMS and microsystem design.
- CO2. Explain microfabrication techniques and materials used in MEMS.
- CO3. Design the MEMS system for the given industrial application.
- CO4. Integrate MEMS for sensing and actuation purposes.
- CO5. Assess the MEMS and its packaging for the given application.

Prerequisite: Basic Electronics, Materials Science, Control Systems

Course Content:

Unit No.	Description	Hrs.
1	Introduction to MEMS and Microsystems Overview and evolution of MEMS, MEMS vs. conventional systems, Applications in robotics, automation, automotive, biomedical, and consumer electronics, Scaling laws and miniaturization, MEMS markets and industry trends	06
2	Materials for MEMS Substrate materials: silicon, glass, polymers, metals, Material properties relevant to MEMS (mechanical, thermal, electrical), Thin film deposition techniques (PVD, CVD, epitaxy), Structural vs. sacrificial layers, BioMEMS materials and considerations	06
3	MEMS Fabrication Techniques Bulk micromachining and surface micromachining, LIGA process and deep reactive ion etching (DRIE), Lithography: optical, electron beam,	06

	Wet and dry etching, Wafer bonding and packaging, Cleanroom requirements and process flows	
4	MEMS Sensors and Actuators Working principles of MEMS sensors: piezoresistive, capacitive, thermal, piezoelectric, Common MEMS sensors: accelerometers, gyroscopes, pressure sensors, micro-mirrors, Actuators: electrostatic, thermal, piezoelectric, shape memory alloy (SMA), Integration of sensors/actuators with control electronics, Case studies in robotic and automation systems	06
5	Modeling and Simulation of MEMS Devices Mechanical modeling: beam theory, stress-strain analysis, Electrical and fluidic domain modeling, Coupled field analysis (electromechanical), Lumped element modeling and equivalent circuits, Introduction to MEMS design software (e.g., COMSOL, CoventorWare)	06
6	MEMS Packaging, Testing, and Applications MEMS packaging challenges (hermetic sealing, thermal effects), Testing techniques (static and dynamic), Failure modes and reliability analysis, Commercial MEMS devices in automation: motion sensors, inertial measurement units (IMUs), Future trends: NEMS, IoT-integrated MEMS, soft MEMS	06

References:

Text Books-

- 1 MEMS, N. P. Mahalik, Tata McGraw-Hill Publications, 2007
- 2 Fundamentals of Microelectromechanical Systems (MEMS), Chang Liu, Pearson

Reference Books-

1. MEMS and Microsystems: Design and Manufacture, Tai-Ran Hsu, McGraw-Hill
2. Introduction to Microelectromechanical Systems Engineering, Nadim Maluf and Kirt Williams, Artech House

Class: T.Y. B.Tech.	Semester- VI	L	T	P	Credits
Course Code: RA308	Course Name: Mechatronic System Design	3	-	-	3

Course Description:

This course provides a comprehensive introduction to the design and integration of mechatronic systems. Students will explore the fundamental concepts of mechanical, electrical, and software engineering, learning how to combine these disciplines to create efficient and functional automated systems. Through this course, students will develop critical problem-solving skills and gain the ability to effectively collaborate across multidisciplinary teams. By the end of the course, students will be proficient in designing and analyzing integrated mechatronic systems for various applications in industries such as robotics, automation, and product development.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Summarize the basics and key elements of mechatronic design process.
- CO2. Interpret the basic system modelling compared to traditional design process.
- CO3. Practice Modelling and simulation of a mechatronic system
- CO4. Organize real-time interfacing of a mechatronic system.
- CO5. Construct different case studies of mechatronic system design.

Prerequisite: The students should have knowledge of basic electronics, electrical and mechanical systems

Course Content		
Unit No.	Description	Hrs
1	Introduction Overview of Mechatronics: Definition, importance, and application areas, Key elements of Mechatronics, Mechatronic System Design Process: Requirements gathering, conceptual design, prototyping, and testing, Difference between traditional and concurrent design process, Ergonomics and Safety.	06
2	Sensors and Actuators Sensors: Introduction & Types of sensors. Actuators: Electric motors, hydraulic actuators, pneumatic actuators, and electrical actuation systems & solenoids. Selection of sensors and actuators for various applications.	06
3	Automation & Controllers: Automation in Mechatronics: PLCs, SCADA and industrial automation systems - Introduction, definitions, PLC block diagram, Difference between Relay panel and PLC, Selection of PLC, Introduction to Ladder logic programming. Introduction to SCADA systems. Introduction to HMI and Distributed PLC.	06

	Microcontroller and Microprocessor- Introduction, Comparison of Microcontroller and Microprocessor, Architecture – Pin configuration of 8051 Microcontroller.	
4	Mechatronic System Modelling & Simulation: Introduction, Model Categories, Model Development, Engineering Systems: Rotational-Translational, electro-mechanical, Dynamic responses of system-first order, second order systems -Performance measures, Simulation Process: Initialization, Iteration & Termination.	06
5	Real Time Interfacing: Introduction, selection of interfacing standards, elements of data acquisition and control systems, Overview of I/O process, general purpose I/O cards and its installation, Data conversion process, Application software, man machine interface.	06
6	Mechatronic System Design Case Study: Project Definition and Specification: Setting clear goals, timelines, and resource allocation for a mechatronic project, System Integration: Designing and integrating subsystems, Prototyping and Testing: Techniques for rapid prototyping and iterative testing to validate design choices, Design Review and Presentation, Pick and Place robots, Auto focus camera etc.	06

References:

Text Books:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.).
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Reference Books:

1. Mechatronics, H.M.T., McGraw Hills Educations, New Delhi, 2000



Class: T.Y. B.Tech.	Semester-VI	L	T	P	Credits
Course Code: RA310	Course Name: Noise and Vibration	3	-	-	3

Course Description:

The Noise and Vibration course aims at introducing the students with fundamental terms, measurement techniques and control methods for noise and vibration in different applications of robotics and automation. The learnings from the course will help the students to identify the sources of vibration and noise, select noise and vibration transducers, measure and control noise and vibration in different applications.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain the fundamentals terms related to noise and vibration.
- CO2. Determine the natural frequency and damping of single degree of freedom vibrating systems.
- CO3. Determine the amplitude of vibration of the systems subjected to forced vibrations.
- CO4. Select the vibration transducer for measurement of vibrations in robotic and automation applications.
- CO5. Select the microphone for measurement of noise in robotic and automation applications.
- CO6. Apply the methods to control noise and vibration in robotic and automation applications.

Prerequisite: Engineering Mathematics

Course Content

Unit No.	Description	Hrs
1	Fundamentals of Noise and Vibration Vibration: Definition, causes, effects, sources, fundamental terms, equivalent stiffness of springs in series and parallel Noise: Definition, sources, fundamentals terms, units (decibel, dB (A) and SPL), Harshness	6
2	Single Degree of Freedom Systems Damped free vibrations, undamped free vibrations, equation of motion, types of damping, logarithmic decrement, problems	6
3	Forced vibrations of Single Degree Freedom Systems Steady state forced vibration, sources of excitation, impressed harmonic force, impressed force due to rotating unbalance, base excitation, transmissibility and isolation, problems	6
4	Vibration measurement and applications	6

	Vibration measurement system, vibration transducers: Piezoelectric transducers and linear variable differential transformer transducer, Vibration pickups: Vibrometer, Accelerometer, Vibration exciters- Mechanical exciters, impact hammer and electrodynamic shaker, signal conditioners, selection of accelerometers	
5	Noise measurements and instrumentation Noise measurement system, Microphones – types of Microphones, Sound intensity measurement, noise severity criteria, various types of acoustic testing chambers, source identification, standards of noise level and exposure limits, selection of microphones	6
6	Noise and Vibration Control Review of vibration control measures, unconstrained and constrained layer damping treatment, balancing, introduction to active vibration control, identification of noise source, noise radiation and transmission; design principles for noise reduction, sound absorbing materials, sound absorption and reflection coefficients, noise reduction coefficient, applications in Robotics and Automation	6

References –

Text Books:

1. G.K. Grover, Mechanical Vibrations, Nem Chand & Bros.
2. Vibration and Noise for Engineers: Kewal Pujara , Dhanpat Rai And co.

Reference Books:

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
2. Theory of Vibrations with Applications: W T Thomson CBS Publishers Delhi
3. Mechanical Vibrations: S S Rao Addison-Wesley Publishing Co.
4. Fundamentals of Vibration: Leonard Meirovitch , McGraw Hill International Edison.
5. Principles of Vibration Control: Asok Kumar Mallik, Affiliated East- West Press.
6. Mechanical Vibrations A H Church ,John Wiley & Sons Inc
7. Mechanical Vibrations J P Den Hartog, McGraw Hill.
8. Mechanical Vibration Analysis: Srinivasan, McGraw Hill.

Class: T.Y. B.Tech.	Semester-VI	L	T	P	Credits
Course Code: RA312	Course Name: Lean Manufacturing	3	-	-	3

Course Description:

Lean Manufacturing is about creating value. The Lean process starts with creating value for the ultimate customer which requires providing the right product at the right time for the specified price. While all manufacturing attempts to do this, what makes Lean Manufacturing distinct is the relentless pursuit and elimination of waste. Students will learn the key concepts and tools of lean manufacturing, including the identification and elimination of various types of waste, implementation of visual management techniques, application of the 5S methodology, value stream mapping (VSM), A3 problem-solving, and flow principles.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Discuss the objectives & concepts in Lean Manufacturing.
- CO2. Explain the tools and methods of Lean Manufacturing.
- CO3. Analyze the issues in Lean implementation.
- CO4. Explain the JIT in manufacturing.
- CO5. Distinguish between Lean, TPS, ERP and ISO 9001:2000

Prerequisite: Nil

Course Content		
Unit No.	Description	Hrs
1	Introduction to lean manufacturing Objectives of lean manufacturing-key principles and implications of lean manufacturing- traditional Vs lean manufacturing.	06
2	Lean manufacturing concepts Value creation and waste elimination- main kinds of waste pull production-different models of pull production-continuous flow-continuous improvement / Kaizen worker involvement -cellular layout- administrative lean.	06
3	Lean manufacturing tools and methodologies Standard work - communication of standard work to employees -standard work and flexibility -visual controls-quality at the source- 5S principles preventative maintenance-total quality management-total productive maintenance changeover/setup time -batch size reduction -production leveling.	06
4	Value stream mapping The as-is diagram-the future state map-application to the factory simulation scenario-line balancing -Poke Yoke -Kanban – overall equipment effectiveness	06
5	Just in time manufacturing	06

	Introduction - elements of JIT - uniform production rate - pull versus push method- small lot size - quick, inexpensive set-up - continuous improvement. Optimised production technology.	
6	One-piece flow Process razing techniques – cells for assembly line – case studies. Implementing lean: Road map-senior management Involvement-best practices Reconciling lean with other systems: Toyota production system-lean six sigma-lean and ERP lean with ISO9001:2000. Different ISO standards and its importance. ISO 14229:01, Various case studies of implementation of lean manufacturing at industries.	06

References:

Text Book:

1. Askin R G and Goldberg J B, Design and Analysis of Lean Production Systems, John Wiley & Sons Inc., 2003.
2. Micheal Wader, Lean Tools: A Pocket Guide to Implementing Lean Practices, Productivity and Quality Publishing Pvt Ltd, 2002.

Reference Books:

1. Richard B Chase, F Robert Jacobs, Nicholas J Aquilano, Operations Management for Competitive Advantage, McGraw Hill/Irwin, 2003, 10th Edition.
2. The Toyota Leaders – An Executive Guide, Masaaki Sato, Vertical Inc, New York, 2008
3. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003
4. Mikell P. Groover (2002) _Automation, Production Systems and CIM.
5. Rother M. and Shook J, 1999 _Learning to See: Value Stream Mapping to Add Value and Eliminate Muda', Lean Enterprise Institute, Brookline, MA.

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: OE3084	Course Name: Materials Management	3	--	--	3

Course Description:

Any engineering project can be completed by consuming resources. Project materials constitute major portion of project cost averagely to the tune of 65% over and above this at the rate of 10-15 % goes in management of these materials. Engineering refers to providing optimized solutions. Research shows that, 1% saved through materials management is equal to 6-10 % increase in sells volume. This course floated as open elective at VI semester of B. Tech would be applicable to all branches, as materials and their management is required by all disciplines. This course will help to find, procure, store, manage and utilize materials in an optimized manner. Students will also be familiar with international purchase, negation and decision making related to materials.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Apply management principles to material management.
2. Develop and apply codification and standardization process.
3. Derive material procurement plan and evaluate vendors.
4. Develop stores layout for optimum stores management.
5. Apply inventory control techniques for material management.
6. Apply M.R.P. logic and systems to material management.

Prerequisite:

Basic knowledge of the materials as a resource, basic mathematical operators.

Course Content		
Unit No	Description	Hrs
1.	Introduction to Material Management Importance of materials management, Materials function, Need of Integrated Concept, Scope of material management, Organizations for materials management, span of Control.	06
2.	Codification and Standardization Standardization and simplification, Aim, Pro's and Con's and scope of Standardization, Classification and levels of standards. Codification, Nature, process, methods and advantages of codification.	06
3.	Purchasing and vendor development Functions, steps, purchasing cycle. Types of buying, Details of International buying, Procedure, Relevance of Good Supplier Need for Vendor Evaluation-Goals of Vendor Rating-Advantages of Vendor Rating, Negotiation.	06
4.	Warehousing and stores management	06

	Layout of stores and warehouse, material handling in stores, physical control of stocks: obsolete, surplus and scrap management, accounting and record keeping of stores	
5.	Inventory Management and Control ABC analysis- advantages, mechanism, purpose, objectives Importance & Scope of Inventory Control, Types of Inventories, Costs Associated with Inventory, Inventory Control, Selective Inventory Control, Economic Order Quantity, Safety Stocks	06
6.	Materials Requirement Planning (MRP) Introduction, objectives, Terminology, Functions served by MRP, MRP Logic, systems and output, Management information form, Lot size consideration, Introduction to Manufacturing resource planning (MRP II)	06

References:

Text Books:

- Gopalkrishna & Sudarsan, 1. Materials Management, An Integrated approach, 3, PHI.
- Waters, Inventory Control and Management, Wiley.

Reference Books:

- C. M. Sadiwala, Ritesh C. Sadiwala, 1. Materials and Financial Management, 2, New Age International Publishers.
- J. R. Tony Arnold, Stephen N. Chapman and Lloyd M. Clive, Introduction to Materials Management, 6, Pearson Publication.
- Materials Management-Procedures, Texts & Cases, A.K. Dutta, Pearson.
- Bailey/Farmer/Crocker/Jessop- Pearson, Procurement Principles & Mgt.
- Inventory Management – Principles and Practices –Narayan/Subramanian– Excel.
- Martand Telsang, Industrial engineering and production management- -S. Chand publication.

Class: T. Y. B. Tech.	Semester: VI
Course Code: OE350	Course Name: Operations Research

L	T	P	Credits
3	-	-	3

Course Description:

This course is intended to provide students with a knowledge that can make them appreciate the use of various research operations tools in decision making in organizations. Operations Research is the study of scientific approaches to decision-making. Through mathematical modelling, it seeks to design, improve and operate complex systems in the best possible way. The mathematical tools used for the solution of models are either deterministic or stochastic, depending on the nature of the system modelled. In this class, we focus on basic deterministic models and methods in Optimization Techniques.

Course Learning Outcomes:

- After successful completion of the course, students will be able to,
- CO1. Identify the necessity and scope of operation research in decision making.
 - CO2. Formulate and solve linear programming problems using mathematical models and various optimization techniques.
 - CO3. Apply quantitative analysis methods to real-world decision-making scenarios in various industries.
 - CO4. Evaluate and improve decision-making processes under uncertainty

Prerequisite: Possess basic knowledge of mathematics.

Course Content		
Unit No	Description	Hrs
1	Introduction: Introduction: Importance of optimization techniques, Applications of Optimization techniques in construction industry, Operations Research models, Phases of OR, Limitations of OR Linear programming	06
2	Linear Programming Problem: Formulation of LPP, Solution by Graphical Method, Simplex Method, Sensitivity analysis	06
3	Transportation Problem: Transportation Problem and its variants- Unbalanced, Maximization, Restrictions on route.	06
4	Assignment Problem: Assignment problem and its variants- Non-Square, Maximization, prohibited assignments, Alternate possible solutions.	06
5	Decision Strategies: Decision strategies – decision making under certainty – decision making under risk – decision making under uncertainty – formulation – decision criterion	06
6	Game Theory: Game Theory, Characteristics of game, Game model, Rules for game theory, Mixed Strategies (2×2 games), (2×n).	06

References:

Reference Books:

- Er. Prem Kumar Gupta, Dr. D. S. Hira, "Operations Research" S. Chand publications.
- Taha, H.A., "Operations Research - An Introduction", Prentice Hall.
- J. K. Sharma, "Quantitative Techniques-for managerial decisions", Macmillan Business books.
- Singiresu S. Rao, "Engineering Optimization", New Age International Publishers.



Class: T. Y. B. Tech	Semester: VI	L	T	P	Credits
Course Code: OE358	Course Name: Plumbing (Water and Sanitation)	3	-	-	3

Course Description:

This subject deals with the Plumbing system and its codes for civil engineering practices. This course is designed to fulfill the requirements of plumbing systems for residential, and industrial building construction. This course will help to select appropriate fixtures, fittings, and treatments based on the user's requirements. A major emphasis in the course is on water plumbing and sanitary fittings.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the scope and purpose of building industry codes and standards
- CO2. Explain different plumbing fixtures and its working.
- CO3. Prepare layout of sanitary drain and storm drain.
- CO4. Calculate water requirement and suggest layout for water supply.
- CO5. Discuss functions of WTP and STP in plumbing system.

Prerequisite: Possess basic knowledge of construction activities, Environmental engineering, Building planning and design.

Course Content		
Unit No	Description	Hrs
1.	Importance of Codes, Architectural and Structural Coordination Codes and Standards: Scope, purpose; codes and standards in the building industry, UIPC-I, NBC and other codes, Local Municipal Laws, approvals, general regulations, standards. Architectural and Structural Coordination Provisions for plumbing systems, coordination during the planning stage, various agencies involved and their roles, space planning for plumbing systems, plumbing shafts, basements and terraces planning, sunken toilets, location of columns and beams, slabs position, the importance of ledge walls, protection of pipes and structures, waterproofing.	06
2.	Plumbing Terminology Plumbing Fixtures: readily accessible, aerated fittings, flood level rim, floor sink, flushometer valve, flush tanks, lavatories, macerating toilet, plumbing appliances: Traps, Drainage, Valves and Water supply meter.	06
3.	Plumbing Fixtures and Fittings Introduction to Drainage Fixture Units (DFU): pipes, water closets, bidets, urinals, flushing devices, washbasins, bath/shower, toilets for differently abled, kitchen sinks, water coolers, drinking fountain, clothes washer, dishwasher, mop sink, overflows, strainers, prohibited fixtures, floor drains, floor slopes,	06

	hot water temperature controls, installation standard dimensions in plan and elevation, introduction to vent size and vent requirement, the purpose of venting, vent connections, vent stacks, cleanouts, venting of interceptors,	
4.	Sanitary Drainage and Storm Drain One pipe and Two pipe systems, different pipe materials and jointing methods, special joints, hangers and supports, protection of pipes and structures, alternative materials, workmanship, prohibited fittings and practices, T and Y fittings, cleanouts, pipe grading, fixtures below invert level, sizing case study as per NBC, safety,	05
5.	Water Supply, Grey and Reclaimed Water Sources of water, potable and non-potable water, reclaimed water, calculating daily water requirement and storage, hot and cold water distribution system, backflow prevention, air gap, cross connection control, controls and thermal expansion fixtures its installation and testing, protection of underground pipes, introduction to Water Supply Fixture Units (WSFU) and sizing.	05
6.	Introduction to WTP and STP Need to reduce and reuse, 24x7 water supply, metering and sub-metering, typical daily water and wastewater calculations for a project. Sources, utility and treatment of water, parameters of water quality, parts of water treatment plant (WTP), disinfection methods, storage conditions, RO water systems, rainwater harvesting treatment, desalination. Grey water and black water, characteristics of domestic sewage, sewage treatment methods, aerobic and anaerobic treatment, level of treatment, reclaimed water.	08

References:

Codes of Practice:

- Bureau of Indian Standards IS 17650 Part 1 and Part 2 for Water Efficient Plumbing Products, BIS, New Delhi
- National Building Code (NBC) of India
- Uniform Illustrated Plumbing Code-India (UIPC-I) An IPA and IAPMO (India) Publication
- Water Efficient Products-India (WEP-I), An IPA and IAPMO (India) Publication
- Water Efficiency and Sanitation Standard (WE. Stand) An IPA and IAPMO (India) Publication

Reference Books:

- Berry, "Water Pollution", CBS Publishers.
- An IPA and IAPMO (India), "A Guide to Good Plumbing Practices", An IPA and IAPMO (India) Publication.
- O.P. Gupta, "Elements of Water Pollution Control Engineering", Khanna Book Publishing, New Delhi.

Class:- T.Y. B. Tech.	Semester- VI	L	T	P	Credits
Course Code : OE372	Course Name : Industrial Safety	3	–	–	3

Course Description:

This course provides a comprehensive understanding of industrial safety, focusing on electrical hazards, fire risks, machine safety, and plant design with emphasis on prevention and control measures. Students gain knowledge of occupational health, ergonomics, safety psychology, and stress management for promoting workplace well-being. The course also introduces accident prevention principles, hazard identification techniques, and risk analysis tools. Overall, it builds strong awareness of safety management systems, statutory provisions, and environmental protection in industrial settings..

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Analyze electrical and fire hazards by examining safe operating limits.
- CO2. Evaluate the suitability of machine guards, hazardous-area electrical equipment, and high-pressure system.
- CO3. Evaluate plant layout, ventilation, thermal comfort, and industrial lighting systems with reference to National Building Code
- CO4. Design safety and health management strategies incorporating ergonomics, occupational health, stress management
- CO5. Analyze accident causation using hazard identification tools and evaluate preventive measures through plant safety inspection.

Prerequisite: Basic Electrical Engineering, Workshop Practice / Manufacturing Processes and Environmental Studies / Industrial Engineering

Course Content		
Unit No	Description	Hrs.
1	Electrical Hazards: Safe limits of amperages, voltages, distance from lines, etc., Joints and connections, Overload and Short circuit protection, Earthing standards and earth fault protection, Protection against voltage fluctuations, Effects of shock on human body Hazards from Borrowed neutrals, Electrical equipment in hazardous atmosphere, Criteria in their selection, installation, maintenance and use, Control of hazards due to static electricity. Energy Conservation & Safety	06
2	Fire and other Hazards: General causes and classification of fire, Detection of fire, extinguishing methods, firefighting installations with and without water. ii. Machine guards and its types, automation. High pressure hazards, safety, emptying,	06

	inspecting, repairing, hydraulic and nondestructive testing, hazards and control in mines.	
3	Plant design and Housekeeping: Plant layout, design and safe distance, Ventilation and heat stress, Significance of ventilation, Natural ventilation, Mechanical ventilation Air conditioning ii. National Building code part VIII and Building service, Thermal comfort, Indices of heat stress, Physiology of heat regulation. Statutory provisions.	06
4	Industrial Lighting: Purpose of lighting, Uses of good illumination, recommended optimum standards of illumination, Design of lighting installation, Standards for lighting and color. Testing and Maintenance of ventilation systems.	06
5	Safety and Health Management Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety. Safety Psychology, Safety information system, Ergonomics - Introduction, Definition, Objectives, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders., Importance of Industrial safety. Safety of Environment	06
6	Principles of accidents prevention Definition: Incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc. Accident Prevention: Theories / Models of accident occurrences, Principles of accident prevention, Accident and Financial implications, Hazard identification and analysis: fault tree analysis, Event tree analysis, failure modes and effects analysis, Hazop studies, Job safety analysis – examples, Plant safety inspection - objectives and types check procedure inspection report.	06

References -

Text Books:

- The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai
- Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi

Reference Books:

- Industrial Safety –National Safety Council of India ISHET.
- Dr. K. U. Mistry - Fundamentals of Industrial Safety & Health, Siddharth Prakashan, Ahmadabad.

Class:- T.Y. B. Tech.	Semester-VI	L	T	P	Credits
Course Code : OE342	Course Name : Data Mining	3	-	-	3

Course Description:

The course helps to learn concepts, techniques and tools they need to deal with various facets of data mining process, including data collection and its preprocessing. The orientation of course is to understand the data mining concepts. The course helps to learn Data mining techniques and algorithms. It assists in comprehending the data mining environments inline to supervised and unsupervised learning patterns. The organization of web data inline to structured/unstructured will be examined. Moreover, a holistic view data mining applications will be surveyed.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Compare various conceptions of data mining as evidenced in both research and application
- CO2. Apply Classification and Clustering techniques for real time problems
- CO3. Characterize the various kinds of patterns that can be discovered by association rule mining
- CO4. Analyze web mining techniques for structured/un-structured data patterns
- CO5. Evaluate mathematical methods underlying the effective application of data mining

Prerequisite: Basic Mathematics, Descriptive statistical techniques.

Course Content		
Unit No	Description	Hrs
1	Introduction Data Mining Tasks, Data Mining Functionalities, Classification of Data Mining Systems, Major Issues in Data Mining, Data Pre-processing: Why Preprocessing, Cleaning, Integration, Transformation, Reduction, Discretization	06
2	Classification Decision Trees, Bayesian Classification, Rule-Based Classification, Neural Network-Based Algorithms, Support Vector Machines, Classification by Association Rule Analysis, Nearest Neighbor Classifier	06
3	Clustering Classification of clustering algorithms, Hierarchical Algorithms, Agglomerative Algorithms, Divisive Clustering, K-Means Clustering, Clustering Large Databases	06
4	Association Rules	06

	What is an Association Rule?, Methods to Discover Association Rules, A Priori Algorithm, Partition Algorithm, FP-Tree Growth Algorithm, Generalized Association Rule	
5	Web Mining Web Mining, Web Content Mining, Web Structure Mining, Web Usage Mining, Text Mining, Unstructured Text, Text Clustering	06
6	Applications Applications and Trends in Data Mining, Data Mining Applications, Social Impacts of Data Mining, Trends in Data Mining	06

References -

Text Books:

- Margaret H. Dunham, "Data Mining Introductory and Advanced Topics", Prentice Hall
- Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques, The Morgan Kaufmann Series in Data Management Systems

Reference Books:

- Arun K Pujari, Data Mining Techniques, University Press
- P. Tan, M. Steinbach and V. Kumar, "Introduction to Data Mining", Addison Wesley

Class:- T. Y. B. Tech	Semester-VI	L	T	P	Credits
Course Code: OE368	Course Name: AI for Agriculture	3	--	--	3

Course Description:

The course introduces students to the intersection of Artificial Intelligence (AI) and agriculture. It focuses on applying AI techniques such as data analysis, computer vision, NLP, and generative AI to solve real-world agricultural problems. Students will explore ethical concerns, sustainable development goals (SDGs), and AI project development. The course includes case studies and practical use cases to enhance experiential learning.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Specify AI fundamentals, domains, and ethical aspects in agriculture.
- CO2. Identify agricultural problems and apply data acquisition techniques.
- CO3. Develop and evaluate AI models for agricultural applications.
- CO4. Use statistical and generative AI methods for agri-analysis.
- CO5. Analyze AI policies, ethical issues, and future agri-trends.

Prerequisite: Basic Statistics and Probability, Fundamentals of Artificial Intelligence and Python Programming.

Course Content		
Unit No	Description	Hrs
1	Introduction to AI in Agriculture Role of AI in agriculture, types and domains of AI, relevance to SDGs, overview of AI Project Cycle, introduction to AI Ethics.	06
2	Problem Scoping and Data Acquisition Problem scoping in agriculture, challenges in Agri-domain, data types, sources, data acquisition, data handling and visualization, AIoT.	06
3	AI Modeling and Deployment Introduction to modeling, training and testing datasets, model evaluation metrics, deployment, practical examples of AI models in Agri-apps.	06
4	Statistical AI Techniques in Agriculture Statistical data analysis, regression and classification techniques, crop yield and damage prediction, introduction to generative AI for data.	06
5	AI Applications: CV and NLP in Agriculture CV techniques and use cases (e.g., crop/rice/livestock), NLP applications (chatbots, market intelligence), ethical implications, generative AI in CV/NLP.	06

6	Policy, Ethics, and Future Trends in AI for Agriculture Ethical considerations in deploying AI solutions in agriculture, privacy and data protection issues, AI policy frameworks, government initiatives, global and national regulations, future trends and opportunities in AI-driven agriculture.	06
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References

Text Books:

- Abhishek Ghosh & Manju Khari, “Artificial Intelligence for Agriculture”, CRC Press.
- Melanie Mitchell, “Artificial Intelligence: A Guide for Thinking Humans”, Penguin.
- J. Zhou, J. Guo, “Artificial Intelligence in Precision Agriculture”, Springer.

Reference Books:

- Rohit Sharma, “AI and IoT for Sustainable Development in Agriculture”, Springer.
- Niall Adams, “Data Science for Agriculture and Environmental Research”, CRC Press.
- Rajalingappaa Shanmugamani, “Deep Learning for Computer Vision”, Packt Publishing.

Class: - T.Y. B. Tech	Semester- VI		L	T	P	Credits
Course Code: OE3401	Course Name: Cyber Security (Open Elective)		3	--	--	3

Course Description:

Cybersecurity is the practice of protecting systems from cyber-attacks. It is important because effective cybersecurity reduces the risks of cyber-attacks. Cybersecurity is a high-demand but changing field. Since hackers are trying to find new ways to access, change, or delete sensitive information and extort money, users must be aware of cyber threats and comply with basic cybersecurity principles. This course will help in understanding cybercrimes, their laws & and various techniques for investigating different cybercrimes. This course also focuses on advanced issues in e-banking and financial crimes

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Describe fundamental terms in cybercrime legislation.
- CO2.** Compare various cyber-attacks & offences.
- CO3.** Analyze the Indian IT Act 2000 & amendments in the IT Act.
- CO4.** Assess social networks and security issues related to social media platforms.
- CO5.** Apply a strategy for creating awareness about cyber security for e-banking and legal issues among the social community.
- CO6.** Devise the best practices and policies in various layers of cyberspace.

Prerequisite: Basic Computer Technology

Course Content

Unit No	Description	Hrs
1.	Introduction to Cybersecurity Defining Cyberspace and Overview of Computer and Technology, Architecture of cyberspace, Communication and web technology, Internet, World Wide Web, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security.	06
2.	Cyber Crime and Cyber Law Classification of cybercrimes, Common cybercrimes - cybercrime targeting computers and mobiles, cybercrime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, viruses and worms, Cybercriminal's modus-operandi, Reporting of cybercrimes, Remedial and mitigation measures, Legal perspective of cybercrime.	07

3.	The Indian IT Act Cybercrime and Legal landscape around the world, cyber laws, challenges faced in designing cyber laws, IT Act: Cyber Crime (Section 65-74), Amendments to the Indian IT Act 2000.	05
4.	Social Media Overview and Security Introduction to Social Networks. Types of social media, social media platforms, social media monitoring, Hashtag, Viral content, social media marketing, social media privacy, Challenges, opportunities and pitfalls in online social networks, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, best practices for the use of social media, Case studies.	06
5.	E-Commerce and Digital Payments Definition of E-Commerce, Main components of E-Commerce, Elements of E-Commerce Security, E-Commerce threats, E-Commerce security best practices, Introduction to digital payments, Components of digital payment and stakeholders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), RBI guidelines on digital payments and customer protection in unauthorized banking transactions. Relevant provisions of Payment Settlement Act, 2007.	06
6.	Digital Devices Security, Tools and Technologies for Cyber Security End Point device and mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third-party software, Device security policy, Cyber Security best practices, Significance of host firewall and Anti-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions.	06

References -

Text Books:

- Sumit Belapure and Nina Godbole, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt. Ltd. (First Edition, 2011)
- Henry A. Oliver, "Security in the Digital Age: Social Media Security Threats and Vulnerabilities", Create Space Independent Publishing Platform. (Pearson, 13th November, 2001)

Reference Books:

- James Graham, Ryan Olson, "Cyber Security Essentials", Rick Howard CRC Press, Taylor & Francis Group, 2011 Edition
- Cyber Crime Impact in the New Millennium, by R. C Mishra, Author Press. Edition 2010.
- Kumar K, "Cyber Laws: Intellectual Property & E-Commerce Security" Dominant Publishers.

Class:- T.Y. B. Tech	Semester-VI		L	T	P	Credits
Course Code : OE364	Course Name : AI for Manufacturing		3	--	--	3

Course Description:

This course introduces the applications of Artificial Intelligence in the manufacturing sector. It explores AI Industry use cases and techniques like quality monitoring, predictive maintenance, and demand forecasting. The course also discusses AI's ethical concerns, AI project cycle and its usability in manufacturing applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Describe Artificial Intelligence and its potential impact in manufacturing.
- CO2.** Apply AI techniques to solve problems in the manufacturing sector.
- CO3.** Demonstrate the use of AI techniques for robotic perception, environment understanding, and intelligent decision-making.
- CO4.** Illustrate key AI techniques used for fault detection and prediction in mechanical and industrial systems.
- CO5.** Explain the principles and techniques of demand forecasting in the context of manufacturing operations.
- CO6.** Examine ethical concerns of AI to create Responsible AI.

Prerequisite: Basics of Manufacturing, Python Programming

Course Content		
Unit No	Description	Hrs
1.	Introduction to AI for Manufacturing Domains of AI, How can AI contribute to Manufacturing, Different AI opportunities in the manufacturing sector, popular use cases in the manufacturing, AI project life cycle and its use in manufacturing sector.	06
2.	AI Modeling and Evaluation Data acquisition, Data analysis and Preprocessing, Model Training, Evaluation, and deployment, Platforms for AI project deployment.	05
3.	Computer Vision and Robotics Process Automation Basic of computer vision, Use of computer vision in manufacturing process, AI for robot perception and decision-making, AI-driven robots and cobots, Path planning and motion control using ML, Human-robot collaboration, Real-world applications: welding, assembly, pick-and-place.	07
4.	Predictive Maintenance Predictive maintenance in manufacturing, AI techniques for fault prediction in mechanical systems, Use cases of AI in equipment maintenance, Vibration analysis and failure prediction.	06
5.	Inferencing on Edge and Demand Forecasting	06

	Edge inferencing, edge inferencing in manufacturing, demand forecasting, solving problem in manufacturing using demand forecasting.	
6.	AI Ethics and Responsible AI AI Ethics, Importance of AI Ethics in manufacturing, Responsible AI, frameworks for developing responsible AI.	06

References -

Text Books:

- Masoud Soroush, Richard D Braatz, "Artificial Intelligence in Manufacturing: Concepts and Methods", Academic Press, Paperback ISBN: 9780323991346
- Andrew Ng, "Machine Learning Yearning", <https://info.deeplearning.ai/machine-learning-yearning-book>
- Xiaofei Wang, Yiwen Han, Victor C. M. Leung, Dusit Niyato, Xueqiang Yan, Xu Chen, "Edge AI: Convergence of Edge Computing and Artificial Intelligence", Springer Singapore.
- Vincent C. Muller, "Ethics of Artificial Intelligence and Robotics", Metaphysics Research Lab, Stanford University.

Reference Books:

- George Chryssolouris, Kosmas Alexopoulos, Zoi Arkouli, "A Perspective on Artificial Intelligence in Manufacturing", Springer, Kindle Edition.
- Kim Phuc Tran, "Artificial Intelligence for Smart Manufacturing: Methods, Applications, and Challenges", Springer International Publishing AG.

Class:- T.Y. B.Tech	Semester-VI	L	T	P	Credits
Course Code :OE348	Course Name: Information Technology Foundation Program	3	-	-	3

Course Description:

This course introduces students to fundamental problem-solving methods, algorithms, and flowcharting techniques used in computing. It covers C programming and basic data structures to develop efficient solutions for computational problems. The course also explores programming paradigms, coding standards, and debugging practices for writing structured and optimized programs. Students learn core object-oriented concepts along with relational data management through ER modeling, normalization, and SQL queries. Additionally, the course provides an overview of essential project management principles, including planning, estimation, scheduling, and risk management.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain fundamental problem-solving methods using logic, algorithms, and flowcharts to represent solutions systematically.
- CO2. Develop C programs using control structures, arrays, strings, functions, and basic data structures to solve computational problems.
- CO3. Analyze different programming paradigms, coding standards, optimization techniques, and debugging methods to improve program structure and efficiency.
- CO4. Apply object-oriented principles such as abstraction, encapsulation, relationships, polymorphism, interfaces, and packages in program design.
- CO5. Evaluate relational data models using ER diagrams, normalization techniques, and SQL queries to design efficient database systems.
- CO6. Create effective project plans by integrating estimation, scheduling, risk management, communication strategies, and monitoring tools.

Prerequisite:

Basic understanding of computer fundamentals and logical reasoning.

Course Content		
Unit No	Description	Hrs
1	Problem Solving Techniques Introduction to Logic, Introduction to Problem Solving, Introduction to Algorithms, Introduction to Algorithms to Flowcharts	06
2	Introduction to C and Data Structures Computer Terms and Concepts, Introduction to C, Introduction to basic data structures, Selection Control Structure, Iteration Control Structure, Demonstration of 1D and 2D arrays, Function, String, Searching and Sorting Algorithms.	06
3	Programming Paradigms Programming Paradigm, Basic Programming, Coding Standards, Best Practices, Introduction to code optimization, Modular approaches through Functions, Testing and Debugging	06
4	Object Oriented Concepts Introduction to Object Oriented Programming, Abstraction and Encapsulation, Relationships, Polymorphism, Interfaces and Packages	06
5	Relation Data Management Introduction, ER modelling, Normalization, SQL Queries	06
6	Project Management Project Management Concepts, Project Management Activities, Project Estimation, Project Planning and Scheduling, Project Risk Management, Project Execution and Monitoring, Project Communication Management, Project Management Tools, Project Monitoring and Tools	06

References -

Text Books:

- Yashavant Kanetkar, Let Us C, BPB Publications.
- E. Balagurusamy, Programming in ANSI C, McGraw-Hill Education.

Reference Books:

- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, MIT Press.
- Reema Thareja, Data Structures Using C, Oxford University Press.

Class:- T.Y. B. Tech.	Semester-VI		L	T	P	Credits
Course Code: OE366	Course Name: AI for Cybersecurity		03	--	--	03

Course Description:

This course introduces students to the fundamentals of AI in cybersecurity, exploring how AI can both enhance security and introduce new risks. Learners will study secure AI system development, data protection, and sector-specific challenges, while examining real-world applications and current best practices. By the end, students will be prepared to assess and implement AI-driven cybersecurity solutions.

Course Learning Outcomes:

- CO1.** Identify the Role of AI in Cybersecurity
- CO2.** Analyze and Assess Security Risks in AI Systems
- CO3.** Apply Security Best Practices to AI Development and Deployment
- CO4.** Evaluate Sector-Specific AI Cybersecurity Challenges

Prerequisites: Basic knowledge of networks, scheduling, and cybersecurity concepts

Course Content		
Unit No	Description	Hrs
1	Introduction to AI and Cybersecurity Overview of cybersecurity: definitions, objectives, and challenges Evolution of AI in cybersecurity, Key cybersecurity threats and vulnerabilities, Role of AI in modern cyber defense, Ethical, legal, and policy considerations,	06
2	Cybersecurity Foundations for AI Systems ICT infrastructure and AI hosting environments, Security management of ICT infrastructure, Cybersecurity certification and compliance, Cybersecurity legislation and policies relevant to AI, Basic security principles and procedures, Risk management and conformity assessment	06
3	AI Fundamentals and Security Implications Types of AI and their applications in cybersecurity, AI system life cycle: development, deployment, operation, and maintenance, Key assets: data, models, artefacts, actors, processes, environments, Threats specific to AI: transparency, interpretability, bias, accountability, Robustness, resilience, and fairness in AI systems, Security controls for AI components	06
4	Data Security in AI Systems Importance of data security in AI, Data supply chain risks and mitigation, Data poisoning and integrity attacks, Data drift and its impact on AI outcomes, Best practices: encryption, digital signatures, provenance tracking, Secure storage and trust infrastructure	06
5	AI-Specific Cybersecurity Practices Secure AI model development and deployment, Adversarial attacks and defenses AI model explainability and auditability, Monitoring and incident response for AI systems, Security testing and validation for AI, Regulatory frameworks and guidelines for AI security	06
6	Advanced Topics in AI Cybersecurity Sectoral cybersecurity practices for AI (health, energy, telecom), High-risk AI systems and compliance with regulations, Emerging threats and future trends in AI cybersecurity, international standards and best practices, Case studies: AI-driven attacks and defenses, Survey analysis and conclusions from industry reports	06

References –

Text Books

- Alessandro Parisi, Hands-On Artificial Intelligence for Cybersecurity, Packt Publishing.
- Mark Stamp, Introduction to Machine Learning for Security Professionals, Wiley.

References

- Ishaani Priyadarshini, Rohit Sharma, Artificial Intelligence and Cybersecurity: Advances and Innovations, Routledge.

Class:- T.Y. B. Tech	Semester- VI
Course Code: OE3284	Course Name: Supply Chain Management

L	T	P	Credits
3	--	--	3

Course Description:

In a typical supply chain, raw materials are procured and items are produced at one or more factories, shipped to warehouses for intermediate storage, and then shipped to retailers or customers. Consequently, to reduce cost and improve service levels, effective supply chain strategies must take into account the interactions at the various levels in the supply chain. In this course, students will be able to present and explain concepts, insights, practical tools, and decision support systems important for the effective management of the supply chain. This course will help the students to develop an understanding of the following key areas and their interrelationships:

- The strategic role of a supply chain
- The key strategic drivers of supply chain performance
- Supply chain network design and analytical methodologies for supply chain analysis

This course will help the students to learn the strategic importance of good supply chain design, planning, and operation for every firm. The students will be able to understand how good supply chain management can be a competitive advantage, whereas weaknesses in the supply chain can hurt the performance of a firm.

Course Learning Outcomes:

After successful completion of the course, the students will be able to,

- CO1. Identify the role and key issues in the supply chain management.
- CO2. Select appropriate SC strategies under given situations.
- CO3. Design the inventory system and level at various locations in supply chain.
- CO4. Specify the distribution and transportation requirements.
- CO5. Develop appropriate strategic alliances for enhancing the performance of SC
- CO6. Describe different strategies used to mitigate risk in global supply chain.

Course Content		
Unit No.	Description	Hrs
1.	Understanding of Supply Chain: Objectives of a supply chains, decision phases, stages of supply chain, supply chain process view, cycle view of supply chain process, push/pull view of supply chain processes, key issues in SCM	06
2.	Supply chain drivers and obstacles: Four drivers of supply chain- inventory, transportation, facilities and information; A framework for structuring drivers in supply chain, supply chain strategies, strategic fit, Obstacles to achieve strategic fit, value of information, Bullwhip effect and reduction	06
3.	Role of Inventory Management in supply chain:	06

	Role of forecasting, characteristics of forecast, Components of forecast, Basic approach to demand forecasting, Role of cycle inventory, Economics of scale to exploit fixed costs and discounts, cycle time related costs, Safety inventory, single stage inventory model, risk pooling, centralized and decentralized systems of planning inventory in supply chain	
4.	Network Planning and supply chain Integration: Network design, warehouse location, service level requirements, integrating inventory positioning and network design, supply chain integration. Push-pull and pull-push type systems, demand driven strategies, Impact of internet on supply chain strategies, Transportation in a supply chain, facilities affecting transportation decision, modes of transportation and their performance characteristics.	06
5.	Distribution strategies and strategic alliances: Introduction, Centralized vs. decentralized control, direct shipment, cross docking, push based vs. pull based supply chain, third party logistics (3PL), Retailer-Supplier relationship issues, requirements, success and failures, distributor integration types and issues, role of pricing and revenue management in supply chain. Role of sourcing in supply chain, supplier scoring and assessment.	06
6.	Global logistics and Risk management: Agile supply chains, Introduction to global SCM, risk management, issues in international SCM, regional differences in logistics, design for logistics, supplier integration in to new product development, pricing issues and smart pricing. IT and Business processes in supply chain.	06

References: -

Text books:

- Supply Chain Management: Strategy, Planning, and Operation, Sunil Chopra and Peter Meindel, Prentice Hall.

Reference Books:

- Logistics and Supply Chain Management, Christopher martin, Pearson Education Asia.
- Marketing logistics: A supply chain Approach, Kapoor KK; KansalPurva, Pearson Education Asia.
- Designing And Managing Supply Chain Concepts, Strategies And Case Studies, David Simchi-Levi, Ravi Shankar; McGraw Hill Publication.

Class:-T.Y. B. Tech	Semester-VI	L	T	P	Credits
Course Code: OE3324	Course Name: Entrepreneurship Development	3	--	--	3

Course Description:

Now a day's all engineers run behind campus interviews and secured job. Very few of them think seriously about their career as entrepreneur. Instead becoming job seekers, they should become job creators. Nation also expects same thing from young technocrats. Therefore, startup India & Make in India mission are in progress. Technopreneurs should take advantage of these mission to start their career as Entrepreneur.

Up till now belief was Entrepreneurs are born and cannot be created. But research by David Mc Leland & Entrepreneurship Development Institute of India, Ahmedabad, has proved that with proper guidance & training successful entrepreneurs can be created. With reference to guide lines provided by EDI Ahmedabad, NIESBUD, NIMSME, syllabus for course is designed

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Identify, analyze & select business opportunity to suit his personality based on SWOT analysis
- CO2. Make market research & survey for selected business
- CO3. Prepare and apprise detailed Project Report
- CO4. Formulate plan for financial management of project.
- CO5. Apply managerial inputs for starting & establishing his own business

Prerequisite:

Student from any branch of engineering with strong passion for Entrepreneurship

Course Content		
Unit No	Description	Hrs
1.	Entrepreneurial motivation: Entrepreneur-Definition, Concept, importance, nature, types, entrepreneurial culture, growth, entrepreneurial traits & motivations. Entrepreneurship: Aspects, Barrier to entrepreneurship, Entrepreneur competencies, Industrial Economics,	06
2.	Project identification: Concept of Project & classification, searching for business idea, opportunity finding, Scanning Business Idea & development. Selection of Product/ Service, core competence, product life cycle, new product development process, creativity and innovation in product modification/development.	06

	Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection. Factors affecting selection of location for an industry. Importance of material handling and its relevance with facility location. Calculate capacity of plant and its relation with economies of scale. Including flexibility	
3.	Design Thinking: Steps in design thinking, application, case study Business Canvas: Importance, construction and application with case study Marketing: Market survey, 4 P of marketing, USP, Branding. JBTD: Jobs to be done	08
4.	Setting Up of Enterprise: Steps for starting small scale industry, whom to approach for what, incentives and subsidies, Role of state development, finance corporations, nodal agencies, Role of consultancy Organization, Lead Bank, various clearances & certificate required for a particular industry, Start Up India & Make in India program. Factory design and Layout	04
5.	Costing and Accounting: Financial appraisal, Direct and Indirect costs, Financial projections, Balance Sheet, Profit and loss account, Income tax, GST, Excise Tax, Long term loan, short term loan, over drafts, letter of credit, working capital management.	04
6.	Project Report: Project Report preparation, Preliminary Project Report, feasibility report, marketing research, Project appraisal, statement of cash flow, accounting ratios, Break-even analysis	08

References: -

Text Books:

- Dynamics of Entrepreneurial Development and Management -By Vasant Desai, Himalaya Publishing House,
- Management of small scale Industries, -By Vasant Desai; Himalaya Publishing House, Delhi
- Small Scale Industries and Entrepreneurship, -By Vasant Desai, Himalaya Publishing House, Delhi.

Reference Books:

- Entrepreneurship Development and Management -By Neeta Bopodikar, Himalaya Publishing House, Delhi
- Project Profiles for S.S.I. Mechanical Products;
- E.D.P. Study Material by Dr. Dinesh Awasthi, Mr. Raman Jossi V Padmananal E.D.I Ahamadabad
- E.D.P. Study Material by MITCON Pune
- E.A.P. Study Material by Mr. Raman Gujaral E.D.I. Ahmadnagar

Class: T.Y. B.Tech.	Semester-VI	L	T	P	Credits
Course Code: OE3024	Course Name: Reliability Engineering	3	-	-	3

Course Description:

The concepts of Reliability Engineering are applicable to almost every engineering system to ensure that reliable products are designed and manufactured. Therefore, this course is introduced as an Open Elective for Third Year students. This course aims at making the students capable of analyzing the reliability of engineering systems and ensure that they study the techniques to determine and improve the reliability of different engineering systems. The course introduces fundamental concepts of reliability engineering, techniques to calculate the reliability of different types of systems, methods to improve the reliability, system reliability modelling, reliability analysis methods, reliability testing and software reliability.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain the fundamental concepts and applications of Reliability Engineering.
- CO2. Determine the reliability of simple and complex systems
- CO3. Apply different reliability allocation techniques for reliability analysis
- CO4. Apply the principles and techniques for reliability design and improvement
- CO5. Apply different techniques for reliability analysis of engineering systems
- CO6. Explain the methods of testing for hardware and software reliability

Prerequisite: Engineering Mathematics

Course Content

Unit No.	Description	Hrs
1	Introduction to Reliability Engineering Reliability Engineering and Applications, failures and failure modes, reliability function, MTTF, MTBF, MTTR, repairable and non-repairable items, reliability economics, safety and reliability, quality and reliability, cost and system effectiveness, life characteristic phases, IoT in reliability analysis	6
2	System Reliability Modeling Discrete probability distribution, Continuous Probability Distributions, Reliability Block Diagram, Hazard rate and failure density, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, Series system, Parallel system, Series-Parallel system, Complex system, k-out-of-m systems	6
3	Reliability Allocation Definition, reliability allocation techniques, equal apportionment, AGREE method, ARINC method, feasibility of objectives apportionment technique, minimum effort method	6
4	Design for Reliability	6

	Reliability design process, reliability considerations in design, stress-strength interaction, factor of safety, margin of safety, loading roughness, redundancy, reliability improvement techniques, types of redundancy, Markov models, single unit, two unit and three-unit Markov models	
5	Techniques for Reliability Analysis Failure modes, effects and criticality analysis (FMECA), fault tree analysis, minimal cut set method, minimal tie set method, Ishikawa diagram, case study,	5
6	Reliability Testing Introduction to reliability testing, Accelerated Life Testing and Highly Accelerated Life Testing (HALT), Highly Accelerated stress Screening (HASS), software reliability: fundamental concepts, comparison and prevention, software testing	6

References –

Text Books:

1. L. S. Srinath, Reliability Engineering, East-West Press, 4th Edition.
2. Elsayed A. Elsayed, Reliability Engineering, Addison Wesley, 1996.
3. Kailash C. Kapur, Reliability Engineering, 2012

Reference Books:

1. Ebeling C.E., Introduction to Reliability and Maintainability Engineering”, Overseas Press. Pvt Ltd.
2. B.S.Dhillon, Maintainability, Maintenance and Reliability for Engineers, CRC Press.
3. L.S.Srinath, Reliability Engineering, EWP, 3rd Edition 1998
4. Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Springer, 2007
5. Roger D Leitch, Reliability Analysis for Engineers: An Introduction, Oxford University Press, 1995
6. S S. Rao, Reliability Based Design, Mc Graw Hill Inc. 1992
7. E.E.Lewis, Introduction to Reliability Engineering, John Wiley and Sons.
8. Basu S.K, Bhaduri, Terotechnology and Reliability Engineering, Asian Books Publication.
9. Dr. A. K. Gupta, Reliability, Maintenance and Safety Engineering.
10. John D. Musa, Software Reliability Engineering, Tata McGraw Hill.

Class: T.Y. B.Tech.	Semester-VI	L	T	P	Credits
Course Code: OE362	Course Name: Flexible Manufacturing System	3	-	-	3

Course Description:

A flexible manufacturing system (FMS) gives manufacturing firms an advantage to quickly change a manufacturing environment to improve process efficiency and thus lower production cost. However, upfront costs may be greater for installing specialized equipment that allows for flexibility and customization. This course imparts knowledge of FMS evolution, objectives, applications and focuses on FMS layout, processing stations material handling systems etc.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Apply the concepts to the development of FMS.
- CO2. Discuss the control structure used in manufacturing systems.
- CO3. Discuss the Scheduling & Loading of FMS.
- CO4. Identify hardware and software components of FMS.
- CO5. Summarize the concepts of Cellular Manufacturing.
- CO6. Summarize the concepts of Additive Manufacturing.

Prerequisite: Nil

Course Content

Unit No.	Description	Hrs
1	Introduction Flexible and rigid manufacturing, F.M. Cell and F.M. System concept, Types and components of FMS, Tests of flexibility, Group Technology and FMS, unmanned factories, Economic and Social aspects of FMS. Advantages and disadvantages of FMS Group technology	06
2	Control structure of FMS Architecture of typical FMS, Automated work piece flow, Control system architecture – Factory level, Cell level; hierarchical control system for FMS, LANs - characteristics, transmission medium, signalling, network topology and access control methods.	06
3	Scheduling & Loading Of FMS Introduction, Scheduling of operations on a single machine, 2 machine flow shop scheduling, 2 machine job shop scheduling, scheduling 'n' operations on 'n' machines, Scheduling rules, loading problems, Tool management of FMS, material Handling system schedule. Problems.	06
4	FMS hardware and software FMS computer hardware and software, general structure and requirements, PLCs, FMS installation and implementation, acceptance testing Characteristics	06

	of JIT pull method, small lot sizes, work station loads, flexible work force, line flow strategy. supply chain management	
5	Cellular Manufacturing Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing. Various case studies of implementation of FMS at industries.	06
6	Additive Manufacturing Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM - Classification of AM processes-Benefits- Applications.	06

References –

Text Books:

1. Shivanand H.K., Benal MM, Koti V, “Flexible Manufacturing System”, New age international (P) Limited, New Delhi, 2006
2. Mikell P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, PHI, 2008

Reference Books:

1. Kalpakjin, “Manufacturing Engineering and Technology ”, AddisonWesley Publishing Co., 1995.
2. Viswanadhan, N. & Narahari, Y. (1998), "Performance Modelling of Automated Manufacturing Systems", PHI
3. Pinedo, Michael & Chao, Xiuly (1999), "Operations Scheduling with Applications in Manufacturing & Services", McGraw Hill International Editions (with 2 Floppy Disks of LEKIN Scheduling Software)
4. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006

Class: - Third Year B. Tech	Semester-VI	L	T	P	Credits
Course Code: OE344	Course Name: Supply Chain Analytics	3	-	--	3

Course Description:

In a typical supply chain, raw materials are procured, and items are produced at one or more factories, shipped to warehouses for intermediate storage, and then shipped to retailers or customers. Consequently, to reduce cost and improve service levels, effective supply chain strategies must consider the interactions at the various levels in the supply chain. In this course, students will be able to present and explain concepts, insights, practical tools, and decision support systems important for the effective management of the supply chain. This course will help the students to develop an understanding of the following key areas and their interrelationships:

- The strategic role of a supply chain
- The key strategic drivers of supply chain performance
- Supply chain network design and analytical methodologies for supply chain analysis

This course will help the students to learn the strategic importance of good supply chain design, planning, and operation for every firm. The students will be able to understand how good supply chain management a competitive advantage can be, whereas weaknesses in the supply chain can hurt the performance of a firm.

Course Learning Outcomes:

- After successful completion of the course, the students will be able to,
- CO1. Identify the role and key issues in the supply chain management.
- CO2. Explain the important supply chain drivers and their significance in strategic planning.
- CO3. Estimate the demand using suitable demand forecasting method.
- CO4. Design the inventory system and level at various locations in supply chain.
- CO5. Design the supply chain network using appropriate network design methodology for the given problem.
- CO6. Describe the importance of handling uncertainty in supply chain using decision tree.

Course Content

Unit No.	Description	Hrs
1.	Understanding of Supply Chain: Introduction to Supply Chain Management, Evolution of Supply Chain Management, Analytics in Supply Chain Management, Supply Chain Planning, Different views of Supply Chain	06
2.	Supply chain drivers and obstacles: Four drivers of supply chain- inventory, transportation, facilities and information; A framework for structuring drivers in supply chain, supply chain strategies, strategic fit, Obstacles to achieve strategic fit, value of information,	06

3.	Demand forecasting in Supply chain: Bullwhip Effect and Time Series Analysis, Exponential Smoothing Method of Forecasting, Measures of Forecasting Errors, Tracking Signal and Seasonality Models, Forecasting using multiple characteristics in Demand Data and Inventory Management in Supply Chain	06
4.	Inventory Management in supply chain: Inventory Management in Supply Chain, Role of cycle inventory, Economics of scale to exploit fixed costs and discounts, cycle time related costs, levels of safety, single stage inventory model, risk pooling, centralized and decentralized systems of planning inventory in supply chain, Multi echelon Inventory Management.	06
5.	Network Design and analytics in supply chain: Network design, warehouse location, service level requirements, integrating inventory positioning and network design, supply chain integration, Optimal Level of Product Availability in Supply chain. Time Value of money in Supply Chain, Different types of Analytics in Supply Chain	06
6.	Handling uncertainty and future trends of Supply chain Using Decision Tree for handling Uncertainty, Example of using Decision Tree incorporating Uncertainty in Single Factor, Example of using Decision Tree incorporating Uncertainty in two Key Factors, Modelling Flexibility in Supply Chain, Trends, Challenges and Future of Supply Chain	06

References:

Text books:

- Supply Chain Management: Strategy, Planning, and Operation, Sunil Chopra and Peter Meindel, Prentice Hall.

Reference Books:

- logistics and supply chain management, Christopher martin, Pearson Education Asia.
- Marketing logistics: A supply chain Approach, Kapoor KK; Kansal Purva, Pearson Education Asia.
- Designing and managing supply chain concepts, strategies and case studies, David Simchi-Levi, Ravi Shankar; McGraw Hill Publication.



K. E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Syllabus for B.Tech. Robotics & Automation
To be Implemented for 2024-28 NEP Batch
Department of Robotics & Automation

Class: - T.Y. B. Tech.	Semester-VI	L	T	P	Credits
Course Code: OE346	Course Name: Mobile Robotics	3	-	--	3

Course Description: Mobile robotics refers to the field of robotics that focuses on the design, construction, operation, and use of robots that are capable of autonomous movement. Unlike stationary robots, mobile robots have the ability to navigate and operate in various environments, both indoor and outdoor, without being confined to a fixed location.

Key components and aspects of mobile robotics include 1. Sensors 2. Actuators 3. Control Systems 4. Power Systems 5. Communication 6. Autonomy.

One of the defining features of mobile robots is their ability to operate autonomously, meaning they can make decisions and navigate without direct human intervention. This autonomy can range from simple behaviors, like obstacle avoidance, to complex tasks such as mapping an unknown environment. Applications of mobile robotics are diverse and include Autonomous Vehicles: Self-driving cars, drones, and other autonomous vehicles are examples of mobile robots used for transportation and surveillance.

Warehouse Automation: Mobile robots are employed in warehouses for tasks such as inventory management, order picking, and transportation of goods.

Search and Rescue: Mobile robots equipped with sensors and cameras can be deployed in disaster-stricken areas to search for survivors or assess the situation.

Agriculture: Agricultural robots can be used for tasks like planting, harvesting, and monitoring crops.

Healthcare: Mobile robots can assist in hospitals for tasks like delivery of supplies, patient assistance, or disinfection.

Mobile robotics is an interdisciplinary field that combines elements of computer science, mechanical engineering, electrical engineering, and other related disciplines to create intelligent and adaptable robotic systems capable of navigating and performing tasks in dynamic environments. Advances in mobile robotics continue to drive innovation in various industries, making these systems increasingly capable and versatile.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Identify and explain the main components of a robot, including sensors, actuators, and control systems.
- CO2. Solve forward and inverse kinematics problems for mobile robots.
- CO3. Apply basic motion planning algorithms such as A* and Dijkstra's algorithm.



CO4. Apply Simultaneous Localization and Mapping.
 CO5. Implement inter-robot communication and human-robot interaction.

Prerequisite: Basics of algebra, kinematics.

Course Content		
Unit No	Description	Hrs
1.	Robot locomotion: Types of locomotion, hopping robots, legged robots, wheeled robots, stability, manoeuvrability, controllability.	06
2.	Robot components and applications, sensors and actuators in mobile robots, robot control architecture, introduction to microcontroller science embedded systems.	06
3.	Kinematics and Dynamics-robot kinematics -forward and inverse kinematics, Robot dynamics-Newton-Euler equations, Lagrange's equations. holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.	06
4.	Motion Planning and Path following-basics of motion planning, path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP), trajectory generation and control for robots. Localization and Mapping-sensor based localization simultaneous localization and mapping (SLAM), types of maps in mobile robots	06
5.	Perception for Mobile Robots-computer vision for mobile robots, sensor fusion, object detection and recognition. Control system for mobile robots-PID control, model predictive control (MPC), reactive and deliberative control strategies.	06
6.	Mobile Robot Communication-wireless communication for mobile robots, inter robot communication, human robot interaction.	06

References -

Textbooks:

1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011.
2. "Robotics: Modelling, Planning and Control" by Bruno Siciliano and Lorenzo Sciavicco.
3. "Probabilistic Robotics" by Sebastian Thrun, Wolfram Burgard, and Dieter Fox.

Reference Books:

1. Peter Corke, Robotics, Vision, and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.

Class: T. Y. B. Tech	Semester: VI		L	T	P	Credits
Course Code: OE352	Course Name: Image Processing		3	-	-	3

Course Description:

Image Processing has fundamental importance to fields where images are enhanced, manipulated, and analyzed. They play a key role in remote sensing, medical imaging, inspection, surveillance, autonomous vehicle guidance, and more. Students will benefit from the direct visual realization of image processing concepts, and learn how to implement efficient algorithms to perform or design applications for various tasks.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Explain different concepts and processes in digital image processing.
- CO2.** Apply different image processing operations on an image.
- CO3.** Analyze various operations on image using different tools.
- CO4.** Compare various filtering, enhancement, segmentation and classification techniques used in image processing.
- CO5.** Design various applications in Image Processing.

Prerequisite: Basic knowledge of Linear Algebra and programming language

Course Content		
Unit No.	Description	Hrs
1.	Digital Image Fundamentals: Components of image processing system, human and computer vision, hierarchy of image processing system, applications, image formation and digitization, binary, gray scale and color images.	06
2.	Image Enhancement & Image Filtering: Gray level transformation function: Image Negatives, Log Transformations, Power Law Transformation, Piecewise Linear Transformation Functions, Histogram equalization, Basics of spatial filtering, smoothing and sharpening spatial filter.	06
3.	Morphological Image Processing: Dilation and erosion, opening and closing operation, Hit or miss transformation, Edge Detection, Applications of Morphological Image Processing.	06
4.	Image Segmentation: Thresholding, Role of illumination, global and adaptive thresholding, pixel-based segmentation, region-based segmentation and edge-based segmentation.	06
5.	Image Shape and Classification:	06

	Shape representation, Feature space, Clusters and classification techniques, Supervised and Unsupervised classification, Basic algorithms: Boundary extraction, region filling, thinning and thickening, skeletons.	
6.	Real Life Applications and Case Studies: Face recognition, Object detection, Object Classification, various case studies and applications of Digital Image Processing.	06

References:

Text Books:

1. R.C. Gonzalez & R.E. Woods, Digital Image Processing, Pearson.
2. Pratt W.K, Digital Image Processing, John Wiley & Sons.

Reference Books:

1. R.C. Gonzalez & R.E. Woods, Digital Image Processing using MATLAB, Pearson.
2. Georgy Gimel' farb, Patrice Delmas, Image Processing and Analysis: A Primer, World Scientific.



Class: T. Y. B. Tech	Semester: VI
Course Code: OE354	Course Name: Fuzzy Logic and Neural Network

L	T	P	Credits
3	-	-	3

Course Description:

This comprehensive course delves into the core principles of Soft Computing, covering topics such as fuzzy sets and operations, relations and composition, and fuzzification and defuzzification. Students will gain a solid understanding of soft computing methodologies, including the distinctions between soft and hard computing, and the role of biological neural networks in computational models. The course further explores neural network fundamentals, including various learning mechanisms and architectures, paving the way for advanced topics such as recurrent neural networks and their applications.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1.** Develop a comprehensive understanding of fuzzy sets, operations, and their applications in problem-solving scenarios.
- CO2.** Solve problems related to relations and composition.
- CO3.** Design, implement various neural network architectures.
- CO4.** Analyze various neural network architectures for real-world applications.

Prerequisite: Basic knowledge of probability and control system

Course Content		
Unit No.	Description	Hrs
1.	Foundations of Fuzzy Sets Fuzzy sets and membership, Universe of discourse, Classical sets operations and properties, Fuzzy sets operations and properties, Mapping of Classical Sets to Functions, Problems based on Fuzzy sets operations and properties.	06
2.	Fuzzy Relations and Operations Cartesian product, Cardinality of Crisp Relation, crisp relations, fuzzy relations, Operations on Fuzzy Relations Properties of Fuzzy Relations, membership functions, Composition, Fuzzy Cartesian Product and Composition, Value Assignments, Problems based on relation and composition.	06
3.	Membership Functions, Fuzzification and Defuzzification Features of the Membership Function, Fuzzification, Defuzzification to Crisp Sets, λ -Cuts for Fuzzy Relations, Defuzzification to Scalars, Problems based on λ -Cuts and Fuzzy Relations, Fuzzy Control system.	06
4.	Introduction to Soft Computing and Neural Networks What is soft computing? Differences between soft computing and hard computing, Biological Neural Networks, The Journey of Neural Networks, Activation Function, Soft Computing constituents.	06
5.	Neural Networks and Learning Mechanisms	06

	Learning, Supervised Learning, Unsupervised Learning, Supervised mechanism, Unsupervised Mechanism, Reinforcement Learning, Learning Rules, The Perceptron learning, Architecture of Neural Networks, Feedforward Networks, Multilayer feedforward network.	
6.	Advanced Neural Networks and Applications Recurrent Neural Network or Feedback Network, Backpropagation Networks, Radial Basis Function Network, applications of neural networks to pattern recognition systems such as character recognition, face recognition, application of neural networks in image processing.	06

References:

Text Books:

1. Kuntal Barua and Prasun Chakrabarti, Fundamentals of Soft computing, BPB Publications.
2. S.N. Shivanandam, Principle of soft computing, Wiley.
3. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India.
4. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson publication.

Reference Books:

1. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall.
2. David E. Goldberg, Genetic Algorithms in Search, Optimization & Machine Learning, Addison Wesley.

Class:- T.Y. B. Tech	Semester- VI		L	T	P	Credits
Course Code: OE356	Course Name: Project Management		3	--	--	3

Course description:

To improve and update knowledge of new entrepreneurs in the areas of project preparation & appraisal techniques; decision-making process in the sector of industrial, infrastructure & sustainable opportunities that would lead to improved viability, returns and effective investment decisions. Writing a business plan which can gain interest of the fund providers like venture capitalists and other sources of funding.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain concept of project Management,
- CO2. Prepare project analysis
- CO3. Prepare technical appraisal of selected project.
- CO4. Prepare financial appraisal of selected project.
- CO5. Apply different techniques for project management.

Prerequisite:

General knowledge of economics, Project & clear concept about business model.

Course Content		
Unit No.	Description	Hrs.
1.	Overview of Project appraisal: Project Development Cycle, Identifying data requirements and analyzing their suitability for preparation of feasibility studies, project formulation, screening for pre-feasibility studies, stages of feasibility report preparation, Project Analysis including Market Analysis, Technical Analysis & Financial Analysis, applying various techniques and integrating the data gathered into a full-fledged business plan.	07
2.	Project Analysis: Environmental Analysis, Risk Analysis, Infrastructure Development & Financing, Risk Management, Risk identification, Qualitative risk analysis, Quantitative risk analysis, Risk planning, Risk control, Evaluating the rewards & risks for sustainable opportunities. National Cost-Benefit Analysis, Financing Sustainable Opportunities.	06
3.	Project Planning: Planning fundamentals, project master plan, work breakdown structure & other tools of project planning, work packages project organization structures & responsibilities, responsibility matrix, Time and cost estimates with AON and AOA conventions, Budget estimates, Network analysis, Float analysis, crashing concepts	06
4.	Project appraisal:	06

	Technical Appraisal: Operation and Production Plan: Types of production systems, Product design and analysis, New product development, location and layout decisions, project layout, plant and technology choices, product specification and customer needs, production planning and control, Commercializing Technologies	
5.	Commercial Appraisal: Economic feasibility and commercial viability, market analysis, Market Research, Industry Analysis, Competitor analysis, defining the target market, market segmentation, market positioning, building a marketing plan, market strategy. Financial Appraisal: Pro-forma income statements, financial projections, working capital requirement, funds flow and Cash flow statements; Ratio Analysis.	06
6.	PERT, CPM, Resource allocation: Tools & techniques for scheduling development, crashing of networks, time-cost relationship, and resource levelling multiple project scheduling. Computer applications and Software for Project Management	05

References:

Text Books:

- Dwivedi, A.K.: Industrial Project and Entrepreneurship Development, Vikas Publishing House
- Prasanna Chandra: Project Planning estimation and assessment.
- Gray and Larson: Project Management the Managerial Process, Third edition, Tata McGraw-Hill

References:

- Bangs Jr., D.H., *The Business Planning Guide*, Dearborn Publishing Co.
- Katz, J.A. and Green, R.P., *Entrepreneurial Small Business*, McGraw Hill
- Mullins, J. and Komisar R., *Getting to Plan B*, Harvard Business Press
- O'Donnell, M., *The Business Plan: Step by Step*, UND Center for Innovation.
- Scarborough, N.M. and Zimmerer, T.W., *Effective Small Business Management*, Pearson
- Pickle, H.B. and Abrahamson, R.L., *Small Business Management*, Wiley
- Desai, V., *Dynamics of Entrepreneurial Development & Management*, Himalaya Publishing
- Kao, J., *Creativity & Entrepreneurship*, Prentice Hall
- Singh, Narendra, *Project Management & Control*, Himalaya Publications

Class: T. Y. B. Tech	Semester: VI		L	T	P	Credits
Course Code: OE370	Course Name: AI for Sustainability		3	-	-	3

Course Description:

This course introduces the fundamental concepts of artificial intelligence (AI) and sustainability and applications for sustainable development. The course aims to enable learners to understand the potential of AI for addressing environmental, social and economic sustainability challenges through case studies and real-life solutions. Students will explore environmental, social and economic dimensions of sustainability and identify AI appropriateness in each context. They will also evaluate the impact of AI projects in different dimensions and discuss crucial critical consideration.

The course will be Open Elective choice for all students

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain fundamentals of Artificial Intelligence and Sustainability.
- CO2. Analyze the potential and impacts of AI to address environmental, social and economic challenges.
- CO3. Develop critical thinking skills for evaluating and comparing AI solutions in sustainable context.
- CO4. Apply AI, IOT and other technologies to prototype sustainable solutions for A real-world challenges.

Prerequisite: Basic knowledge of Environmental and Sustainability knowledge, Basics of Mathematics and Programming skills.

Course Content		
Unit No.	Description	Hrs
1.	Introduction to AI and Sustainability: Introduction to Sustainability, Approaches to Sustainability, Dimensions of Sustainability, Introduction to AI and Domains of AI, AI Ethics, AI Contributing to Green Skills, AI's role in achieving sustainability goals.	06
2.	AI Foundations: Supervised, unsupervised, reinforcement learning, Introduction to Neural networks and deep learning, Tools and frameworks for AI: Python, TensorFlow, Scikit-learn.	06
3.	Environmental Sustainability: Introduction to Environmental Sustainability, Business Approach for Environmental Sustainability, AI for Environmental Sustainability, Environmental Challenges for AI, AI in Clean water and sanitation, AI in Climate Action, AI in Affordable and Clean Energy.	06
4.	Social Sustainability:	06

	Introduction to Social Sustainability, Business Approach for Social Sustainability, AI for Social Sustainability, Social challenges for AI, AI in Zero Hunger, Good Health and Well-being, AI in Accident Detection.	
5.	Economic Sustainability: Introduction to Economical Sustainability, Business Approach for Economical Sustainability, AI for Economical Sustainability, Economical Challenges for AI, AI in Decent Work and economic growth, AI in Industry Innovation and Infrastructure, AI in Intelligent Recycling.	06
6.	Case Studies and AI Projects: Steps in AI Project Development, AI in Quality Education, Transportation, healthcare chatbot, Fraud Detection Predictive Maintenance, Sentiment Analysis for social media.	06

References:

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson.
2. Margaret Robertson, "Sustainability Principles and Practice", Routledge.
3. S. Suresh, "Artificial Intelligence for Sustainable Development", Wiley.

Reference Books:

1. Francisco J. Martin and Uwe Meinberg, "Artificial Intelligence for a Better Future: An Ecosystem Perspective on the Ethics of AI and Emerging Digital Technologies", Springer.
2. Klaus Schwab "The Fourth Industrial Revolution", Crown Publishing Group.
3. Peter Dauvergne "AI in the Wild: Sustainability in the Age of Artificial Intelligence", MIT Press.
4. Srikanta Patnaik, Siddhartha Bhattacharyya, Nilanjan Dey (Eds.), "Smart Intelligent Computing and Applications", Springer.

Class:- Third Year B. Tech.	Semester- VI		L	T	P	Credits
Course Code: OE 3242	Course Name : Marketing For Engineers		3	-	-	3
Course Description: Marketing is the core of operating any business. Marketing defines & guides companies for interfacing with customers, competitors, collaborators, and the environment. Marketing helps you plan and execute the creating a value proposition by determining pricing, promotion, and distribution of ideas, goods, and services. It begins with needs and wants determination, assessing the five forces existing in the competitive environment. Selecting the most appropriate customer targets and developing marketing strategy and implementation program for an offering that satisfies consumers' needs better than the competition. Marketing is the art and science of creating customer value in exchange it benefits the organization and its stakeholders.						
Course Learning Outcomes: After successful completion of the course, students will be able to, CO1. Analyze market opportunities by evaluating customers, competitors, collaborators, the business environment, and the strengths and weaknesses of an organization. CO2. Develop effective marketing strategies, including market segmentation, targeting, positioning, and the marketing mix, to achieve organizational objectives. CO3. Design and implement marketing plans by integrating product, pricing, distribution, and promotional strategies to enhance organizational performance. CO4. Evaluate the impact of marketing strategies on customer value, competitive advantage, and organizational profitability. CO5. Communicate and justify marketing recommendations effectively using both qualitative and quantitative analysis through written reports and oral presentations.						
Prerequisite: No prerequisites are needed for enrolling into this Open Elective course.						
Course Content						
Unit No	Description					Hrs
1	Introduction to Marketing: Core concept of marketing, Marketing Process, Function of Marketing Environment, Analyzing needs & trends in micro, macro business environment.					
2	Market Segmentation, Targeting & Positioning: Basis for market Segmentation, Targeting, Positioning. Marketing Mix, Significance of competitive environment.					

3	New Product Development: Product and product line decisions. Product life cycle (PLC), Managing PLC, Test marketing and the new product, Branding and Packaging decisions.	
4	Pricing & Distribution: Price determinants, policies, Methods. Channel Management, Channel conflict and resolutions.	
5	Promotion: Promotion mix, Advertising, Media decisions, Sales Promotion, Personal selling, Managing Sales Force. Advertising Effectiveness.	
6	Strategy: An Introduction, Dealing with competition, Porter's five force model, Strategy, Strategic Analysis & The Market Environment.	
References - Text Books: 1. Philip Kotler, Kevin Lane Keller – “Marketing Management” Pearson Publications. 2. Rajan Saxena – “Marketing Management”, The McGraw-Hill Companies. Reference Books: 1. Vijay Prakash Anand, “Marketing Management – An Indian Perspective” 2. Joel R. Evans, Berry Berman - “Marketing Management”. 3. James C. Anderson James A. Narus Das Narayandas, Business Market Management: Understanding, Creating, and Delivering Value. 4. Stephen Wunker, Capturing New Markets: How Smart Companies Create Opportunities Others Don't.		

Class: T. Y. B. Tech. Civil	Semester: VI		L	T	P	Credits
Course Code : CEMD302	Course Name: Environmental Engineering		3	-	-	3

Course Description:

Environmental Engineering course offered as MDM in 6th semester, which focuses on water supply engineering and wastewater treatment, solid waste management and air pollution. The course enables students to work as a consultant or contractor for infrastructure projects related to water supply and waste management projects. This course intends to build the competency in the students to identify water source, to check water quality, to design of water supply scheme and wastewater treatment plant. Also this course enables student to control environmental degradation by using AI tools.

Course Learning Outcomes:

After successfully completing the course, student will able to:

- CO1. Explain importance of water and wastewater analysis for various parameters.
- CO2. Discuss impact of pollution on man, animal and plants.
- CO3. Prepare layout of water and wastewater treatment process.
- CO4. Design Water and Wastewater Treatment Plant.
- CO5. Apply AI tools for impact of humans on environment.

Prerequisite: Basic knowledge of Environmental Science.

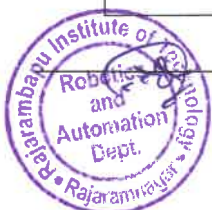
Course Content

Unit No.	Description	Hrs
01	Introduction to Public Health Engineering Introduction to Water Supply Engineering (WSE) Sources of Water and quality issues, water quality requirements for different beneficial uses, Water quality standards, water quality indices, water safety plans, Water Supply systems, need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system;	06

	Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.	
02	Water Treatment Process Layout of Water Treatment Plant, Aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes, design problems on water treatment process, application of SCADA for water treatment plant	06
03	Sewage and Storm Water Collection system Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water- Quantification, and design of Storm water; Sewage and Sludge, Pollution due to improper disposal of sewage,	06
04	Wastewater Treatment Process Layout of Sewage Treatment Plant, wastewater treatment-Physical, chemical and biological treatment,, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes, design problems on components of wastewater treatment, Applications of SCADA for STP operations.	06
05	Solid Waste Management Solid waste, physical and chemical composition of solid waste, Functional elements of solid waste, Treatment and disposal of solid waste and Integrated solid waste management, application of remote sensing and GIS for SWM	06
06	Air Pollution and Control Air pollution, effects of air pollution on man material and vegetation, Metrological aspects of air pollution, Control of air pollution, Vehicular pollution, Global issues of environment viz. Global warming, acid rain, ozone layer depletion, Applications of AI tools for control of air pollution	06

References:

Text Books:



- Punmia B. C. “Water Supply Engineering” Lakshmi Publications Pvt. Ltd. New Delhi
- Punmia B. C. “Wastewater Treatment and Reuse” Lakshmi Publications Pvt. Ltd. New Delhi
- Modi P. N. “Water Supply Engineering” Standard Book House, New Delhi
- Modi P. N. “Wastewater Treatment and Reuse” Standard Book House, New Delhi
- Rao M. N. & Datta A. K. “Wastewater Treatment” Oxford and IBH publishing Co. Pvt. Ltd. New Delhi.

Reference Books:

- Metcalf and Eddy, “Wastewater Engineering: Treatment & Reuse” Tata McGraw Hill Publication.

Class:-T.Y.B.Tech	Semester-VI	L	T	P	Credit s
Course Code : CSMD302	Course Name :Artificial Intelligence	3	-	-	3

Course Description:

In this course students will learn the basic concepts and techniques of Artificial Intelligence. These students will be able to develop AI algorithms for solving practical problems.

Course Learning Outcomes:

After successful completion of the course, students will be able to:

- CO1. Explain fundamental concepts and applications of AI
- CO2. Apply appropriate search techniques and heuristic methods to solve them efficiently.
- CO3. Describe appropriate knowledge representation using logic inference.
- CO4. Analyze the Planning and Understanding schemes for the goal stack.
- CO5. Analyze Understanding, perception, constraint-based reasoning
- CO6. Evaluate Modern AI applications and ethical considerations

Prerequisite:

Basic knowledge of logical reasoning and Probability theory.

Course Content		
Unit No	Description	Hrs.
1	Introduction: Definition and history of Artificial Intelligence, Scope of Artificial Intelligence, Agents and Environment, Concept of Rationality, The nature of Environment, The structure of Agents	6
2	Problem Solving and Search Techniques: Problem-Solving Agents, Production systems, Problem Characteristics, Heuristic functions: Hill climbing and local search techniques, Best-First search, Constraint Satisfaction Problems (CSP).	6
3	Knowledge Representation and Logic: Propositional logic: syntax and semantics, Predicate logic: quantifiers, inference rules, Resolution principle in propositional and predicate logic, Knowledge representation techniques: Procedural Vs. Declarative Knowledge.	6
4	Planning: Planning problems and components, Goal stack planning, Nonlinear Planning using Constraint Posting, Hierarchical Planning, Partial order planning (introduction), planning in deterministic environments	6
5	Understanding: Level of interactions among components, understanding as a constraint satisfaction, Line labeling, The Waltz algorithm.	6
6	Modern AI Applications: AI applications: Healthcare, Finance, And Robotics, Autonomous systems, Case studies of AI systems, societal impact and ethics of AI.	6

References:

Text Books:

- Artificial Intelligence by Rich and Knight, The McGraw Hill publication
- Artificial Intelligence: A modern approach by Stuart Russel, Peter Norvig, Pearson Education.

References:

- <https://www.edx.org/course/artificial-intelligence-ai>
- <https://www.udemy.com/course/artificial-intelligence-az/>

Class: - T.Y. B. Tech.	Semester- VI	L	T	P	Credits
Course Code: EEMD302	Course Name: Smart Grid	3	--	--	3

Course Description:

This course covers the fundamental aspects of the smart grid, various technologies, communication and applications of renewable sources for developing smart grid. It introduces state of the art smart grid technologies like electric vehicles, microgrids, energy storage, phasor measurement unit and cyber security, etc. In addition, it discusses the architecture of smart grid, various distributed energy sources, smart metering and distribution automation equipment.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Summarize the concept and future of smart grid
- CO2. Develop smart grid architecture
- CO3. Compile various smart grid technologies
- CO4. Identify communication and information technologies for smart grid
- CO5. Elaborate distributed generation and storage technologies
- CO6. Recommend smart metering and distribution automation

Prerequisite: Power system, Renewable energy sources, power system economics

Course Content

Unit No	Description	Hrs
1	Introduction to smart grid: Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India, comparison between smart grid and micro grid. Grid Codes.	06
2	Smart grid architecture:	06

	Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, centralized, distributed and hierarchical control strategies, power line communications, supervisory control and data acquisition system.	
3	Communication technology in smart grid: Introduction to communication technology, Home Area Network (HAN), Neighborhood Area Network (NAN) and Wide Area Network (WAN), two-way digital communications paradigm, synchro-phasor measurement units (PMUs) – wide area measurement systems (WAMS), Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid.	06
4	Information technology in smart grid: Data communication, dedicated and shared communication channels, switching techniques- circuit switching, message switching, packet switching, virtual packet switching, datagram packet switching, standards for information exchange, information security for the smart grid,	06
5	Distributed generation and storage: Introduction to distributed energy sources, solar PV system, wind energy system, microgrids, microgrid architecture, AC micro grid, DC microgrid, storage technologies- battery, super capacitor, compressed air energy storage, pumped hydro energy storage, introduction electric vehicles- vehicle to grid (V2G), grid to vehicle (G2V), vehicle to vehicle (V2V) and vehicle to home (V2H) operation in smart grid.	06
6	Evolution of Smart metering, distribution automation, and AI Applications: The role of Artificial Intelligence (AI) in smart grids in load forecasting, anomaly and fault detection, predictive maintenance, AI-assisted fault isolation and restoration, and optimization of power flow and energy efficiency using real-time smart meter data, enabling intelligent, automated, and resilient power system operation.	06

References -

Text Books:

- Janaka Eknayake, Smart Grid- Technology and applications, Wiley publications.
- A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Application, Springer.

Reference Books:

- S. Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press.
- G. Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press.
- T. Ackermann, Wind Power in Power Systems, Hoboken, N J, USA, John Wiley.



Class: -T.Y. B. Tech	Semester-VI		L	T	P	Credits
Course Code : ECMD302	Course Name : Industrial Electronics		3	-	-	3

Course Description:

This course provides basics of power electronic devices with switching on/off techniques. It also deals with power converters such as AC to DC, DC to DC and DC to AC with their analysis and performance parameters. This course also gives introduction to PLC.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Identify basics Power Electronics devices and components.
- CO2. Illustrate use of Power Electronics.
- CO3. Develop PLC logic using ladder programming.
- CO4. Analyze industrial electronics applications.

Prerequisite:

Knowledge of basic electronics and programming.

Course Content		
Unit No	Description	Hrs
1.	Power Electronic Components Applications of power electronics, Power Electronic System, Power semiconductor devices: power diode, power BJT, Power MOSFET, IGBT, SCR, Diac, TRIAC, Ratings, control characteristics of power devices, Characteristics and specifications of switches, Types of power electronic circuits.	06
2.	Power Converters AC-DC Converters (Rectifiers), DC-DC converters (choppers), DC-AC converter (Inverters), AC-AC Converters (1-phase, 3-phase) Cycloconverters	06
3.	DC and AC Drives Basic characteristics of DC motor, operating modes, DC motor control using choppers and rectifiers, Torque-speed characteristics of induction	06

	motor, speed control techniques of AC motor: stator-voltage, rotor resistance, and v/f control, basic equations, characteristics.	
4.	Introduction to PLC Introduction about industrial automation, History of industrial automation Need of automations in industries, Automation control circuit and power circuit, Control system in Industry, Types of PLCs	06
5.	PLC Programming Types of Programming Languages, Introduction about PLC Programming software, Ladder logic diagram, Structure of program, Procedure for creating ladder diagram, Logical function done by ladder program in software.	06
6.	Applications Industrial conveyor systems, Automatic Bottle Filling System, Traffic Light Control system, UPS, Battery charging circuits and management Systems, Induction heating and dielectric heating.	06

References -

Text Books:

1. M. H. Rashid, Power Electronics Circuits Devices And Applications, PHI
2. C. D. Johnson, Introduction to process technologies, PHI

Reference Books:

1. M. D. Singh and K. B. Khanchandani, Power Electronics, TMH
2. P. C. Sen, Power Electronics, S. Chand publication

Class:- T.Y. B. Tech	Semester-VI
Course Code : CIMD302	Course Name : Software Engineering

L	T	P	Credits
3	--	--	3

Course Description:

This course deals with various concepts of Software Engineering. It includes concepts such as software requirements, software process models, function-oriented and object-oriented design. Software engineering covers the basic concepts such as data analysis, modeling and design required for developing software. It also covers concepts such as Objects, classes, links and associations, generalization and inheritance, aggregation, abstract classes and advanced modeling concepts in UML.

Course Learning Outcomes:

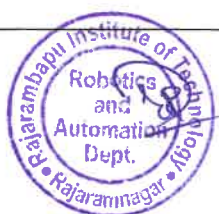
After successful completion of the course, students will be able to,

- CO1.** Describe fundamental concepts in software engineering and project management
- CO2.** Practice software process models for the undertaken software problems
- CO3.** Design function-oriented and object oriented models using modern tools.
- CO4.** Identify classes and build the domain model using advanced concepts in object, dynamic and functional modeling.
- CO5.** Analyze existing software systems using function and object-oriented analysis.
- CO6.** Design models using UML diagrams for software systems: use case, class, sequence, collaboration, activity, state chart diagrams, component and deployment.

Prerequisite: Fundamentals of Computers

Course Content

Unit No	Description	Hrs
1.	Software Requirements, Analysis and Specification	06



	Software requirement analysis and specification, problem analysis, Requirement Specification, Validation, effort estimation, risk management, software testing types	
2.	Software Process Models Waterfall model, V model, Prototyping, Spiral model, Agile software development	07
3.	Function-oriented Design Design principles, module level concepts, Design notation and specification, structured design methodology, Verification	05
4.	Structural Modeling using UML Classes, Relationships, Common mechanisms. Diagrams, Class Diagrams, Interfaces, Types and Roles, Packages, Instances and Object Diagram	06
5.	Behavioral Modeling and Architectural Modeling using UML Interactions, Use cases, Use case diagram, Activity diagrams, Events and signals, State Machines, Components, Deployment, Collaboration, Patterns and Frame works, Component diagrams and Deployment Diagrams	06
6.	Case studies: A. Case study on DFD for Hospital Management System, Library Management System, Railway Reservation System and Online Shopping System. B. Case study design using UML on Banking system, College management system, online food ordering system.	06

References –

Text Books:

4. Pankaj Jalote, “An Integrated Approach to S/W Engineering”, Narosa Publication House.
5. Grady Booch, Jeams Rumbaugh, Ivar Jacobson, “The Unified Modeling Language User Guide” (Addison Wesley)

Reference Books:

6. Roger S. Pressman, “Software Engineering – Practitioner’s Approach”, TATA McGraw-Hill.

Class: - T. Y. B. Tech.	Semester-VI	L	T	P	Credits
Course Code: MEMD304	Course Name: Marketing and Business Fundamentals for New Products	3	--	--	3

Course Description:

In this course, students will learn and understand essential principles and strategies required for successfully launching new products in today's competitive market landscape. From understanding consumer behavior to developing effective branding strategies, students will gain the knowledge and skills necessary to navigate the complexities of bringing innovative products to market.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain product positioning and branding strategies for new products
- CO2. Analyse market trends and consumer behaviour to identify opportunities for new product development.
- CO3. Develop pricing strategies and cost estimation techniques for new products
- CO4. Explain the basics of intellectual property rights and patents in the context of new product development
- CO5. Design distribution channels and sales strategies designed for a new products
- CO6. Create effective marketing communication plans and launch strategies for new products.

Course Content

Unit No	Description	Hrs.
1.	Product Positioning and Branding Strategies: Understanding the concept of product positioning, Identifying target markets and audience segmentation, Crafting a compelling brand identity, Developing brand positioning strategies, Case studies and real-world examples of successful branding campaigns.	06
2.	Market Analysis and Segmentation: Conducting market research to identify opportunities and threats, Analysing market trends and consumer behaviour, Segmentation techniques for targeting	06

	specific market segments, Assessing market competition and differentiation strategies, Utilizing data analytics tools for market analysis	
3.	Pricing Strategies and Cost Estimation: Factors influencing pricing decisions, Cost estimation methods for new product development, Pricing strategies: skimming, penetration, value-based pricing, etc., Pricing psychology and consumer perceptions, Pricing models and simulations	06
4.	Basics of Intellectual Property Rights and Patents : Understanding intellectual property rights (IPR), Overview of patents, trademarks, copyrights, and trade secrets, Importance of protecting intellectual property for new products, Patent application process and requirements, Case studies on patent infringement and legal implications	06
5.	Distribution Channels and Sales Strategies: Exploring various distribution channels: direct vs. indirect, Channel selection and management, Developing sales strategies and distribution plans, Sales forecasting and performance measurement, Building partnerships and alliances for distribution	06
6.	Marketing Communication and Launch Strategies: Crafting effective marketing messages and communication channels, Integrated marketing communication (IMC) strategies, Planning and executing product launches, Leveraging digital marketing tools and social media platforms, Measuring the success of marketing campaigns and adjusting strategies accordingly	06

References: -

Textbooks:

1. Saxena, Marketing Management: Text and Cases.
2. Rao, V.S.P., & Saxena, Marketing Management: Indian Cases.
3. Beri, G.C. Indian Marketing: Text and Cases.
4. Gandhi, M.K., Kumar, A., & Mowen, J.C. Marketing: Concepts and Cases.

Reference Books:

1. Kotler P. and Keller K.L, Marketing Management.
2. Crawford C.M. and Di Benedetto C.A, New Products Management.
3. Armstrong G. and Kotler P, Principles of Marketing.
4. Ries, The Lean Startup: How Today's Entrepreneur use Continuous Innovation to Create Radically Successful Businesses.
5. Boone L.E. and Kurtz D.L, Contemporary Marketing.

Class: - T.Y. B. Tech	Semester-VI	L	T	P	Credits
Course Code: MCMD302	Course Name: Industrial Robotics	3	-	-	3

Course Description:

Industrial robots are nearly on the verge of revolutionizing Manufacture as they end up noticeably more intelligent, quicker, and less expensive, they are being called upon to accomplish more. They are going up against more "human" abilities and attributes, for example, detecting, expertise, memory, and trainability. Accordingly, they are going up against more employments for example, picking and packaging, testing, or investigating items, or assembling minute gadgets.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Explain the basic concepts of Robots.
- CO2. Select an end effector and sensor for application.
- CO3. Explain drives and controls for robotic system.
- CO4. Develop program for robot to perform tasks in industrial applications.

Prerequisite: Sensor and Instrumentation

Course Content		
Unit No.	Description	Hrs.
1	Fundamentals of Robotics: History of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot.	06
2	Grippers for Robotics: Grippers, Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper systems.	06

3	Sensors for Robotics: Types of Sensors used in Robotics, Touch Sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Application of Sensors, Characteristics of Sensing devices, Selection for Particular application Case study.	06
4	Drives and Control for Robotics: Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system, Types of Controllers, Introduction to closed loop control.	06
5	Programming and Languages for Robotics: 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, ROS.	06
6	Application of Robotics in Industry: Application of robot in welding, machine tools, material handling, and assembly operations, parts sorting and parts inspection, AI in robotics, Introduction to Cobots, Future Application and Challenges and Case Studies.	06

References -

Text Books:

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, Robotic Engineering - An Integrated Approach, Prentice Hall Department of Industrial Design Detail Syllabi 318NIT Rourkela India, New Delhi, 2001.
2. Mikell P Groover, Industrial Robotics - Technology, Programming and Applications, McGraw Hill, 1986.
3. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.

Reference Books:

1. James A Rehg, Introduction to Robotics in CIM Systems, Prentice Hall of India, 2002.
2. Deb S R, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.
3. Janaki Raman P A, Robotics and Image Processing, Tata McGraw Hill, 1991
4. Robotics for Engineers -YoramKoren, McGraw Hill International, 1st edition, 1985.

Class: - T.Y B. Tech	Semester – VI	L	T	P	Credits
Course Code: AIMD302	Course Name: Principles of AI	3	-	-	3

Course Description:

In this course students will learn the basic concepts and techniques of Artificial Intelligence. These students will be able to develop AI algorithms for solving practical problems.

Course Learning Outcomes:

After completing this course, students will be able to

- CO1. Articulate basic concepts and techniques of Artificial Intelligence.
- CO2. Apply AI algorithms for solving typical practical problems.
- CO3. Designate appropriate knowledge representation schemes in AI.
- CO4. Analyze reasoning schemes in AI.

Prerequisite:

- Basic knowledge of logical reasoning
- Probability theory.

Course Content		
Unit No	Description	Hrs
1	Introduction The four categories of definitions of AI, Concept of rationality, The AI Problems, Artificial Intelligence Technique, Tic-Tac-Toe game and its data structure, Question-Answering and its one typical data structure, Sample few examples of the state-of-art AI applications.	06
2	Intelligent Agents PEAS description of the task, Simple reflex agents, Model based agents, Learning Agents, advantages, Impact and Examples of AI, Application domains of AI.	06
3	Problem solving techniques State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, best first search, A* search.	06
4	Constraint satisfaction problem	06

	Mean-end analysis, Game playing, Min-Max Search, Alpha-Beta Pruning. Iterative deepening.	
5	Logic and Knowledge Representation schemes in AI Propositional logic, predicate logic, Resolution, Resolution in propositional logic and predicate logic, Clause form, unification algorithm.	06
6	Reasoning schemes in AI Introduction to nonmonotonic reasoning, default reasoning, statistical reasoning, probability and Bayes' theorem, combining uncertain rules.	06
References – Text Books: - Artificial Intelligence by Rich and Knight, The McGraw Hill publication - Artificial Intelligence: A modern approach by Stuart Russel, Peter Norvig, Pearson Education Reference: Artificial Intelligence Electrical Engineering and Computer Science MIT OpenCourseWare		

Class: T.Y.BTech.	Semester- VI	L	T	P	Credits
Course Code: RAMD302	Course Name: Industrial Automation and Control	3	-	-	3

Course Description:

This course offers a comprehensive overview of industrial automation systems, emphasizing their design, components, and applications in various industries. Students will learn about fundamentals of industrial automation, programmable logic controllers (PLCs), PLC programming, material handling and distributed control systems (DCS)

Course Learning Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain need, basic elements, and systems of industrial automation.
- CO2. Develop PLC programming for various applications.
- CO3. Discuss various material handling and identification technologies.
- CO4. Explain basics of DCS and its interfacing.

Prerequisite: NIL

Course Content

Unit No.	Description	Hrs
1.	Fundamentals of Industrial Automation Need of automation, Types of Automation: fixed /programmable /flexible automation, Automation principles and strategies. Basic elements of automated systems: power, program and control, Advanced automation functions: Safety monitoring, Maintenance and Repair diagnostics, Error detection and recovery, Levels of automation.	06
2.	Transfer Lines and Automated Assembly Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications, Analysis of transfer lines with and without storage	06

	buffers. Assembly Automation: Types and configurations, Parts delivery at workstations.	
3.	Fundamentals of PLC Programmable Logic Controller (PLC)- Block diagram of PLC, PLC architecture and programming languages (Ladder Logic, Function Block Diagram, etc.), Basic instruction sets, Input/output modules. Networking of PLC, Overview of safety of PLC with case studies.	06
4.	PLC Programming Basic instructions (AND, OR, NOT, Timer, Counter, etc.), Programming techniques (branching, looping, etc.), Program control instructions, PLC applications like motor control, light control etc.	06
5.	Material handling and Identification Technologies The material handling function, Types of Material Handling Equipment, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.	06
6.	Distributed Control System Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	06

References –

Text Books:

1. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice-Hall.

Reference Books:

1. Webb, John W. Programmable Logic Controllers: Principles and Application, Prentice Hall of India, New Delhi.
2. Petruzella Frank D, Programmable Logic Controllers, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
3. Lucas, M.P., Distributed Control System, Van Nostrand Reinhold Co. NY.
4. Amber G.H & P.S. Amber, Anatomy of Automation, PrenticeHall.

Course Code: RA316	Course Name: Programming and Simulation Lab	-	-	4	2
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Course Description:

This course introduces students to the fundamentals of industrial robot programming and simulation using advanced software tools like RoboDK, ROS etc. It covers offline programming, robot kinematics, path planning, and real-time process simulation relevant to modern manufacturing and automation industries. Students will learn to model robotic work-cells, simulate a variety of operations such as pick and place, palletizing, welding, painting, and inspection, and optimize robot programs for efficiency and accuracy. The course bridges theoretical concepts with hands-on virtual applications, preparing students for real-world robotic automation environments.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Explain Robot programming ecosystem.
- CO2. Create reusable code for robot powered applications.
- CO3. Design a custom robot using programming and simulation tool.
- CO4. Develop and simulate robotic operations.

Prerequisite: Fundamentals of Robotics and Automation, C++/Python Programming

Course Content		
Unit No.	Description	Hrs
1	Introduction to Robot Programming (ROS).	02
2	ROS Workspace and ROS Package.	02
3	ROS Nodes, Topics, Services, Parameters, Launch Files	02
4	Unified Robotic Description Format (URDF) for robot	02
5	Links, Joints, Collisions, Inertia tags in the URDF file	02
6	Launch file to Start the Robot State Publisher with URDF (XML)	02
7	XML using Python launch files	02
8	Make the URDF Compatible with Xacro.	02
9	Functions with Xacro Macros.	02
10	Motion in ROS using Gazebo	02
11	Computer vision in ROS with open CV	02
12	Connecting Hardware with ROS	02
13	Simulation of Basic Pick and Place Operation	02
14	Simulation of Conveyor-based Pick and Place System	02
15	Offline Programming and Simulation of Simple Path Painting	02
16	Simulation of Gantry Robot Operation for Material Handling	02
17	Robotic Simulation of Assembly of Two Mechanical Parts	02
18	Welding Path Generation and Simulation	02
19	Simulation of Robotic Sorting by Color or Size	02
20	CNC Machine Tool Path Execution Simulation	02



21	Simulation of Robotic Visual Inspection Path Planning	02
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*Any 16 experiments

References –

Text Books:

1. Lentin Joseph Robot Operating System for Absolute Beginners, Apress.
2. Brian Gerkey, and William D. Smart, Programming Robots with ROS Morgan Quigley, O'Reilly Media.

Reference Books:

1. Mikell P. Groover, Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill Education
2. Aaron Martinez, Learning ROS for Robotics Programming, Packt Publishing.

Online Resources:

<https://www.youtube.com/@RoboDK3D>

<https://www.youtube.com/@TheConstruct/featured>



Class: T.Y. B.Tech.	Semester-VI	L	T	P	Credits
Course Code: RA318	Course Name: Microcontrollers and Embedded Systems Lab	-	-	2	1

Course Description:

This laboratory course offers practical exposure to the development and analysis of embedded systems using the PIC microcontroller platform. Students will learn to design, code, and test embedded applications using Assembly and Embedded C programming languages. Through hands-on experiments and guided projects, the course emphasizes program development, simulation, and debugging using MPLAB IDE and associated tools. Students will also develop the ability to evaluate application performance by comparing experimental results with theoretical predictions and enhance their technical communication through structured lab documentation.

Course Outcomes:

After successful completion of the course, students will be able to-

- CO1. Develop embedded programs using Assembly and Embedded C language to implement applications on the PIC microcontroller platform.
- CO2. Analyze and debug PIC microcontroller-based programs using MPLAB IDE and simulator tools to ensure functional correctness.
- CO3. Evaluate the performance of implemented microcontroller applications by comparing experimental results with theoretical expectations.
- CO4. Prepare and present well-structured laboratory reports that effectively communicate experimental procedures, outcomes, and technical interpretations.

Prerequisite: Basic Knowledge of Electronics, Programming Fundamentals, Understanding of Computer Architecture and Logic

Course Content		
Unit No.	Description	Hrs
1	Develop logic in Assembly Language Programming to study Arithmetic and Logical Instructions using different Addressing modes of PIC microcontroller.	02
2	Develop logic in Assembly Language Programming to perform Data Transfer operations.	02
3	Develop logic in 'C' Language to blink LED on GPIO with variable time.	02
4	Develop logic in 'C' Language to interface LCD display to PIC 18.	02
5	Develop logic in 'C' Language to Interface relay to PIC microcontroller.	02
6	Develop logic in 'C' Language to create a square wave of 1KHz frequency using Timers of PIC microcontroller.	02
7	Develop a logic in 'C' Language to use on chip ADC in PIC 18	02

8	Develop a logic in 'C' Language to generate PWM signal for DC motor control using PIC18	02
9	Develop a logic in 'C' Language to interface keypad to PIC 18	02
10	Develop a logic in 'C' Language to interface Stepper motor to PIC 18	02
11	Mini-project based on Microcontroller and Embedded Systems	02

Note- Perform any Ten Experiments.

References –

Text Books:

1. Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers" by Jonathan W. Valvano
2. The PIC Microcontroller: Your Personal Introduction" by John Iovine
3. Embedded C Programming and the Atmel AVR" by Barnett, Cox, and O'Cull

Reference Books:

1. PIC Microcontrollers: An Introduction to Microelectronics" by Martin P. Bates
2. Embedded Systems: Introduction to ARM Cortex-M Microcontrollers" by Jonathan W. Valvano
3. Programming and Interfacing PIC Microcontrollers" by Martin P. Bates

Class: Third Year B. Tech.	Semester- VI	L	T	P	Credits
Course Code: RA324	Course Name: Python Programming Lab	-	-	2	1

Course Description:

This laboratory course introduces Python programming with a focus on robotics and automation applications. Students will learn fundamental programming concepts and apply them to robotic systems, sensor data processing, automation logic, and basic control algorithms. The course emphasizes hands-on implementation using Python libraries relevant to robotics, such as NumPy, OpenCV, and basic interfacing concepts. By the end of the course, students will be able to develop simple robotic control programs and automation scripts.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

- CO1. Apply fundamental Python programming concepts to solve engineering problems.
- CO2. Develop Python programs for data acquisition and basic robotic control.
- CO3. Implement automation logic and control algorithms using Python.
- CO4. Design simple applications using Python libraries and simulation tools.

Prerequisite: Fundamentals of Mathematics, Basic Programming Knowledge

Course Content

Experiment No	Description	Hrs
1	Introduction to Python Programming and Development Environment	2
2	Implementation of Operators and Control Structures in Python	2
3	Development of User-Defined Functions and Modular Programming	2
4	Implementation of Object-Oriented Programming Concepts in Python	2
5	File Handling and Data Logging in Python	2
6	NumPy and Pandas for Robotics Applications	2
7	Data Visualization using Matplotlib	2
8	Serial Communication between Python and Microcontroller	2

9	Image Processing Basics using OpenCV	2
10	Implementation of Basic Control Algorithms (ON/OFF and PID Control)	2
11	Automation Script Development using Python	2
12	Development of a Simple Robotics or Automation Application	2

Note- Perform any Ten Experiments.

References -

Textbooks:

1. Python Crash Course – Eric Matthes, No Starch Press.
2. Learning Python – Mark Lutz, O'Reilly Media.

Reference Books:

1. Programming Robots with ROS – Morgan Quigley, Brian Gerkey & William D. Smart, O'Reilly Media.
2. Introduction to Robotics: Mechanics and Control – John J. Craig, Pearson Education.
3. Python for Data Analysis – Wes McKinney, O'Reilly Media.



Class: - T.Y. B. Tech	Semester-VI	L	T	P	Credits
Course Code: SH3065	Course Name: Scholastic Aptitude-II	1	-	2	Audit

Course Description:

Quantitative and Reasoning tests form a major part of most of the competitive exams and recruitment processes. They evaluate numerical ability and problem-solving skills of candidates. Along with the arithmetic abilities, candidate's patience while reading through the question is also tested. Decision making is also a crucial part of the process with a question having multiple solutions and the candidate has to choose the most efficient one.

Fast calculations have become an integral part of a candidate's career. Calculating the remuneration and efficiency, estimating profits and interests on the principal, using a logical approach towards solving a problem is now a routine affair for a professional.

Course Learning Outcomes:

After successful completion of the course, students will be able to,

1. Develop a thorough conceptual understanding and develop a logical approach towards solving Aptitude and Reasoning problems.
2. Understand usage of basic aptitude terms of percentages, averages, ratios and applications of business aptitude terms of profits and interests
3. Develop a bridge in analogies, series and visualizing directions.
4. Apply various short cuts & techniques to manage speed and accuracy to get equipped for various competitive and campus recruitment exams

Prerequisite: Fundamentals of various Mathematical and Arithmetic operations, Calculations.

Course Content		
Unit No	Description	Hrs
1	Speed Time Distance Average Speed, Special Cases of Average Speed, Relative Speed, Cases of relative speed Circular motion, Applications of STD	03
2	Trains Stationary Object with Negligible length, Stationary Object with considerable length, moving object with negligible length, Moving object with considerable length, Including-Excluding Stoppages.	03
3	Boat & Streams Upstream case, Downstream case, Perpendicular movement	03
4	Races Head Start, Dead heat, defeat, 3 man participating in race, ratio related examples	03
5	Permutation & Combination	03

	Difference between P & C, Theorems of Permutation Theorems of Combination, Counting numbers of squares & rectangles, Triangle	
6	Probability Introduction, Range of Probability, Sum & Product Rule, Coins, Dice, Cards, Bags & Balls	03
7	Geometry Triangles, Quadrilaterals, Circles, Polygons	03
8	Mensuration Cube, Cuboid, Cylinder, Cone Sphere, Prism	03
9	Clock Basic, Time lag constant, Standard time of coincidence, Various concepts of hour and minute hand, Questions on strikes of clock, Find time in the mirror, Questions based on faulty clock, Time gains or loss	03
10	Calendar Leap year, Odd day concept, Month code, century codes, Same Calendar concept, Finding day or date (Box method)	03
11	Seating Arrangement Type of arrangements, Types of information, Data extraction, Linear-Non Linear movement, Advance movement	03
12	Complex Arrangement Combination of 2 or more topics, Scheduling of events/months/Days/Years/ lectures, Seating arrangement, Tabular arrangement, Checklist method, Tabular Method (comparison)	03
13	Data Sufficiency Two statements, Five options, Blood relation, Direction sense, Seating arrangement, Coding decoding, Order, ranking / Comparison, Syllogism, Complex arrangement, Puzzles, Ages, Calendar	03
14	True False Statement Types of statements, matrix pattern, Comparison between different elements, Questions based on no. of persons and statements	03

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References -

Reference Books:

1. R. S. Aggarwal, "Quantitative Aptitude", S Chand Publishing, New Delhi.
2. R. S. Aggarwal, "Logical Reasoning", S Chand Publishing, New Delhi.
3. Arun Sharma, "Quantitative Aptitude", McGraw Hill Publishing, New Delhi 7th Edition.
4. Arun Sharma, "Logical Reasoning", McGraw Hill Publishing, New Delhi 3rd Edition.

Class:- Third Year B. Tech.	Semester- VI
Course Code : RA332	Course Name : Minor Project

L	T	P	Credits
-	-	12	6

Course Description:

The Minor Project provides students with an opportunity to solve an engineering problem through the systematic application of engineering principles, analytical methods, experimentation and modern engineering tools. Students are expected to identify engineering requirements, develop appropriate design solutions, perform analysis and modelling, implement and validate the proposed system, and evaluate its performance through testing and experimentation. The course emphasizes engineering design, technical decision-making, innovation, project planning, teamwork and professional ethics. Students shall justify their engineering decisions using appropriate calculations, standards and experimental evidence, and effectively communicate their work through technical documentation, presentations and demonstrations. The course develops the knowledge, skills and professional competencies required for engineering practice and advanced project work.

Course Learning Outcomes:

After successful completion of this course, the students will be able to:
 CO1: Formulate and analyse an engineering problem by integrating knowledge from multiple engineering disciplines and relevant standards.
 CO2: Design, develop and optimize an engineering system using appropriate engineering principles, analytical methods, software tools and experimental techniques.
 CO3: Validate system performance through experimentation, testing and analysis, and recommend suitable design improvements based on engineering evidence.
 CO4: Apply project management practices, engineering standards, sustainability, safety and professional ethics during project execution.
 CO5: Prepare comprehensive technical documentation and effectively communicate engineering solutions through reports, presentations and demonstrations.

Prerequisite: Mini Project-I (Foundation Integration Course) and relevant core courses of the respective program.

Course Activities		
Week No	Description	Hrs
1	Course orientation, project allocation, literature survey, problem identification, requirement analysis and project planning.	
2	Concept generation, system requirements, engineering specifications, feasibility analysis, system architecture and implementation plan.	
3	Detailed engineering design, CAD/modelling/simulation, engineering calculations, component/material selection and Review-I (Problem Definition & Design Review).	
4	Prototype development, fabrication/coding, subsystem implementation and project logbook maintenance.	



K. E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, Affiliated to Shivaji University, Kolhapur)
Syllabus for B.Tech. Robotics & Automation
To be Implemented for 2024-28 NEP Batch
Department of Robotics & Automation

5	Completion of subsystem development, module testing, debugging and system integration.	
6	Performance evaluation, validation against design specifications, refinement of design and Review-II (Implementation & Integration Review).	
7	Experimental testing under different operating conditions, data collection, performance analysis and design optimization.	
8	Final system integration, reliability and safety verification, testing and validation of the engineering system.	
9	Completion of implementation, comparison of predicted and measured results, verification of project objectives and Review-III (Testing & Validation Review).	
10	Preparation of engineering drawings, test reports, user manual, technical documentation and project records.	
11	Preparation of final technical report, presentation, demonstration, incorporation of review suggestions and plagiarism check.	
12	Final report submission, project presentation, demonstration, individual viva-voce and Review-IV (Final Technical Review).	

