K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2024-28 NEP Batch
Department of Electrical Engineering
Rev: EE Course Structure/RIT/03/2024-28

B.Tech. in Electrical Engineering with Multidisciplinary Minor

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Curriculum Structure and Evaluation Scheme

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Department of Electrical Engineering

Rev: EE Course Structure/RIT/03/2024-28

Class: S. Y. B. Tech **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
EE2014	DC Machines and Transformer	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50	40		----	----
EE215	Electrical Circuit Analysis	3	1	-	4	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50	40		----	----
EE211	Mathematics for Electrical Engineers	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50	40		----	----
EE213	Power Transmission and Distribution Systems	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50	40		----	----
	Multidisciplinary Minor-I	3	-	-	3	ISE	20	40	40	----	----
						UT1	15			----	----
						UT2	15			----	----
						ESE	50	40		----	----
SH2174	Environmental Science	1	-	2	2	ISE	50	40	40	--	---
						ESE	50	40		--	--
EE2514	DC Machines and Transformer Lab	-	-	2	1	ISE	----	----		50	50
						ESE	----	----		50	50
EE2574	Computer Programming Lab	-	-	2	1	ISE	----	----		50	50
						ESE	--	--		50	50
EE261	Electrical Maintenance and Troubleshooting	-	-	2	1	ISE	----	----		100	50
	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	-	-	-	100	50
	TOTAL	**16**	**1**	**10**							
	TOTAL CONTACT HOURS	**27**			**22**						

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

Total Contact Hours/week : 27

Total Credits : 22

Sr. No.	Subject Name		Course Code
1.	Professional Skills Development and Foreign Languages	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 – Level III	SH2734
6.		Japanese Language – Level 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)

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Department of Electrical Engineering

Rev: EE Course Structure/RIT/03/2024-28

Class: S. Y. B. Tech **Semester:** IV

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (%Marks)			Practical (%Marks)	
							Max	Min. for passing		Max	Min. for passing
EE2064	Analog and Digital Electronics	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
EE2024	AC Machines	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
EE214	Electrical Measurement and Instrumentation	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			--	---
						UT2	15			---	---
						ESE	50	40		---	---
EE2084	Signals and Systems	3	-	-	3	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		---	---
EE216	Advanced Programming Language for Electrical Engineering	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			--	--
						UT2	15			--	--
						ESE	50	40		--	--
EE2524	AC Machines Lab	-	-	2	1	ISE	---	----	--	50	50
						ESE	--	--	--	50	50
EE2544	Analog and Digital Electronics Lab	-	-	2	1	ISE	---	----	--	50	50
						ESE	---	----	--	50	50
EE262	Electrical Measurement and Instrumentation Lab	-	-	2	1	ISE	---	----	--	100	50
EE268	Mini Project	-	-	2	1	ISE	---	----		100	50
EE270	MOOCS-I**	-	-	-	1	ISE	---	----		100	50
EE266	Advanced Programming Language for Electrical Engineering Lab	-	-	2	1	ISE	---	----		100	50
	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	-	-	--	100	50
	TOTAL	**17**	**-**	**12**	**24**						
	TOTAL CONTACT HOURS	**29**									

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

Total Contact Hours/week : 29

Total Credits : 24

Note: Students are required to undergo industrial training of minimum two weeks in the vacation of Semester-IV and its evaluation will be carried out in the Semester-V.

Note:** MOOCS-I course certification marks will be caried out for the credits

Rajarambapu Institute of Technology Electrical Engineering Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Sr. No.	Subject Name		Course Code
1.	Professional Skills Development and Foreign Languages	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 – Level IV	**SH2644**
6.		Japanese Language – Level IV	**SH2624**

K.E. Society's

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Curriculum Structure and Evaluation Scheme

To be implemented for 2024-28 NEP Batch

Department of Electrical Engineering

Rev: EE Course Structure/RIT/03/2024-28

Class: T. Y. B. Tech **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
EE3034	Power System Analysis	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
EE313	Feedback Control System	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50	40		---	---
EE315	Microcontroller & Its Applications	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		---	---
	Multidisciplinary Minor-IV	1	-	2	2	ISE	--	--	--	100	50
SH3035	Scholastic Aptitude-I	2*			Audit	ISE	100	50 (P/NP)	--	--	--
EE361	Feedback Control System Lab	-	-	2	1	ISE	--	--	--	50	50
						ESE	--	--	--	50	50
EE363	Microcontroller Lab	-	-	2	1	ISE	---	---	--	50	50
						ESE	---	---	--	50	50
EE359	Advanced Software Lab	-	-	2	1	ISE	---	---	--	100	50
EE369	Mini Project-I	-	-	6	3	ISE	--	--	--	50	50
						ESE	--	--	--	50	50
EE365	Industrial Training	-	-	-	1	ISE	---	---	---	100	50
EE367	MOOCS-II**	-	-	-	1	ISE	---	----	---	100	50
	TOTAL	**18+2* = 20***	-	**14**	**27**						
	TOTAL CONTACT HOURS	**34***									

ISE: In Semester Evaluation, UT-I: Unit Test-I, UT-II: Unit Test-II, ESE: End Semester Exam, P = Pass, NP = Not Pass

Total Contact Hours/week : 34*

Total Credits : 27

Note*: Students should complete 5 days (30 Hours) of Scholastic Aptitude training program organized by the Institute.

Note:** MOOC-II course certification marks will be carried out for the credits

Program Elective-I

Sr. No	Course Code	Domain	Course
1	EE3094	**Power and Energy Systems**	Energy Storage Technologies
2	EE3114		Restructured Power System
3	EE3134	**Drives and Control**	Digital Signal Processing
4	EE3154		Electrical Utilization and Traction

Open Elective I			
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 and Fuel Cell Technology	Mechanical Engineering

K.E. Society's

Rajarambapu Institute of Technology, Rajaramnagar

(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2024-28 NEP Batch

Department of Electrical Engineering

Rev: EE Course Structure/RIT/03/2024-28

Class: T. Y. B. Tech **Semester:** VI

Course Code	Course	Teaching Scheme				Evaluation Scheme				
							Theory (%Marks)		Practical (%Marks)	
		L	T	P	Credits	Scheme	Max	Min. for passing	Max	Min. for passing
EE314	Power System Protection	2	-	-	2	ISE	20	40	---	---
						UT1	15		---	---
						UT2	15		---	---
						ESE	50	40	---	---
EE3044	Power Electronics	3	-	-	3	ISE	20	40	---	---
						UT1	15		---	---
						UT2	15		---	---
						ESE	50	40	---	---
EE316	Research Methodology	2	-	-	2	ISE	20	40	---	---
						UT1	15		---	---
						UT2	15		---	---
						ESE	50	40	---	---
	Program Elective-II	3	-	-	3	ISE	20	40	---	---
						UT1	15		---	---
						UT2	15		---	---
						ESE	50	40	---	---
	Open Elective-II	3	-	-	3	ISE	20	40	---	---
						UT1	15		---	---
						UT2	15		---	---
						ESE	50	40	---	---
	Multidisciplinary Minor-V	3	-	-	3	ISE	20	40	---	---
						UT1	15		---	---
						UT2	15		---	---
						ESE	50	40	---	---
SH3065	Scholastic Aptitude-II	2*			Audit	ISE	100	50 (P/NP) --	--	--
EE3544	Power Electronics Lab	-	-	2	1	ISE	--	--	50	50
						ESE	--	--	50	50
EE360	Automation and Control Lab	-	-	2	1	ISE	---	--	100	50
EE364	Power System Protection Lab	-	-	2	1	ISE	--	--	50	50
						ESE	--	--	50	50
EE366	Minor Project	-	-	12	6	ISE	--	--	50	50
						ESE	--	--	50	50
	TOTAL	**16+2* = 18***	-	**18**	**25**					
	TOTAL CONTACT HOURS	**36***								

ISE: In Semester Evaluation, UT-I: Unit Test-I, UT-II: Unit Test-II, ESE: End Semester Exam, P = Pass, NP = Not Pass

Total Contact Hours/week : 36*

Total Credits : 25

Note*: Students should complete 5 days (30 Hours) of Scholastic Aptitude training program organized by the Institute.

Rajarambapu Institute of Technology Electrical Engg. Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Program Elective – II

Sr. No.	Course Code	Discipline	Course
1	EE3064	**Power and Energy Systems**	Electrical Energy Conservation and Auditing
2	EE318		Battery Management Systems
3	EE3104	**Drives and Control**	Advanced Control Systems
4	EE3124		Application of Microcontrollers in Electrical Engineering

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

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Department of Electrical Engineering

Rev: EE Course Structure/RIT/03/2024-28

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
EE411	Solar and Wind Energy Systems	2	-	-	2	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
EE413	Electrical Vehicle	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
EE4034	Electrical Drives	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50	40		---	---
EE419	Control System Design	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	--	---	----	100	50
EE473	Solar and Wind Energy Systems Lab	-	-	2	1	ISE	--	---	----	100	50
EE475	Electrical Vehicle and Drives Lab	-	-	2	1	ISE	--	---	----	50	50
						ESE	--	---	----	50	50
	TOTAL	**17**	**-**	**6**	**20**						
	TOTAL CONTACT HOURS	**23**									

ISE: In Semester Evaluation, MSE: Mid Semester Examination, ESE = End Semester Exam

Total Contact Hours/week : 23
Total Credits : 20

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Program Elective-III

Sr. No.	Course Code	Discipline	Course
1	EE4054	**Power and Energy Systems**	Power System Dynamics and Control
2	EE4074		HVDC Transmission Systems
3	EE4094	**Drives and Control**	Nonlinear Control Systems
4	EE429		Power System Operation and Control

Program Elective-IV Theory

Sr. No.	Course Code	Discipline	Course
1	EE4134	**Power and Energy Systems**	High Voltage Engineering
2	EE4154		Power Quality and Harmonics
3	EE4114	**Drives and Control**	FACTS Controllers
4	EE4174		Smart Grids

Program Elective-IV Lab

Sr. No.	Course Code	Discipline	Course
1	EE465	**Power and Energy Systems**	High Voltage Engineering Lab
2	EE467		Power Quality and Harmonics Lab
3	EE469	**Drives and Control**	FACTS Controllers Lab
4	EE471		Smart Grids Lab

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

Class: Final Year B. Tech **Semester:** VIII

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (%Marks) Max.	Theory (%Marks) Min. for passing		Practical (%Marks) Max.	Practical (%Marks) 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, UT-I: Unit Test-I, UT-II: Unit Test-II, 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 **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, UT-I: Unit Test-I, UT-II: Unit Test-II, 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 **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
ED4104	Project Management (Online Course)	2	-	-	2	ISE	25	40	40	-	-
						ESE	75	40		-	-
ED4044	Commercial Aspects of the Project (Online Course)	2	-	-	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	
	Total	-	-	-	**16**						

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

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

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

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

Multidisciplinary Minor

- Student should choose any one specialization given by the department and complete all the five courses under the specialization to earn 170 Credits.
- Following are the baskets of multidisciplinary minor courses

Multidisciplinary Minor Baskets					
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

	2	ECMD202	Electronics Communication Systems	IV	Engineering
	3	ECMD301	Advanced Communication Systems	V	
	4	ECMD303	Electronic Product Design	V	
	5	ECMD302	Industrial Electronics	VI	
Software Development	1	CIMD201	Data Structures	III	Computer Science & Information Technology
	2	CIMD202	Computer Algorithms	IV	
	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 &	1	RAMD201	Fundamentals of Robotics	III	Robotics & Automation

Automation			& 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 Electrical Engineering with Double Minor (Multidisciplinary and Specialization Minor)

B.Tech. in Electrical Engineering with 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	EEDM3XXX
2	IV	DM – II	EEDM4XXX
3	V	DM – III	EEDM5XXX
4	VI	DM – IV	EEDM6XXX
5	VII	DM – V	EEDM7XXX
6	VIII	DM – VI	EEDM8XXX

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 occurs.
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.

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K.E. Rajarambapu Institute of Technology • Rajarammagar Autonomous 415414

B.Tech. in Electrical Engineering with Honor and Multidisciplinary Minor

B.Tech. in Electrical Engineering with Honor and Multidisciplinary Minor degree

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.	Semester	Course	Code
1	III	Honor - I	EEH3XXX
2	IV	Honor - II	EEH4XXX
3	V	Honor - III	EEH5XXX
4	VI	Honor - IV	EEH6XXX
5	VII	Honor - V	EEH7XXX
6	VIII	Honor - VI	EEH8XXX

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 occurs.
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.

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

B.Tech. in Electrical Engineering-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 Electrical Engineering-Honors with Research and Multidisciplinary Minor degree Student need to earn total 188 Credits which consist 170 credits of regular Multidisciplinary Minor 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 %) Max.	Min. for passing		Practical (Marks %) 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 %) Max.	Min. for passing		Practical (Marks %) Max.	Min. for passing
REH402	Research project phase - II	-	-	-	11	ISE	--	--	--	50	50
						ESE	--	--		50	
	TOTAL	-	-	-	11						

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

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Syllabus of T.Y. B. Tech Electrical Engineering
To be implemented for 2024-28 Batch
Department of Electrical Engineering

Class:- **T.Y. B. Tech**	Semester-**V**
Course Code : **EE3034**	Course Name : **Power System Analysis**

L	T	P	Credits
3	-	--	3

Course Description:
This course introduces the fundamentals of power system components and their representation using the per-unit system. It covers the application of symmetrical components for the analysis of both symmetrical and unsymmetrical faults, addresses key power system stability issues using the equal area criterion, and examines HVDC transmission along with various FACTS devices employed to enhance system stability and overall performance.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Apply per unit system for power system components.
2. Analyze symmetrical faults in power systems.
3. Apply symmetrical component method for unsymmetrical faults in power system
4. Examine power system transient stability.
5. Outline FACTs and HVDC devices for electrical power systems.

Prerequisite: Power System Generation, Power System Economics, Electrical Machines, Mathematics, Basic Electrical Engineering

Course Content

Unit No	Description	Hrs.
1	**Power System Components:** Introduction, single phase solution of balanced three phase networks, single line diagram and the impedance or reactance diagram, per-unit (PU) system Overview of modern power systems, digital twins, and the role of Artificial Intelligence in system modeling, simulation, and decision support.	06
2	**Symmetrical Components:** Symmetrical component transformation, phase shift in star-delta transformers, sequence impedance of transmission lines, sequence impedance and sequence network of power system- sequence impedance and network of synchronous machine, sequence impedance of transmission lines, sequence impedance and networks of transformers	06
3	**Symmetrical Fault Analysis:** Short circuit transients on transmission line, short circuit currents and reactance of a Synchronous Machine, Internal voltages of loaded Synchronous machine under transient Conditions.	06

Rajarambapu Institute of Technology Electrical Engg. Department Rajaram

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

4	**Unsymmetrical Fault Analysis:** Analysis of Single Line to Ground (LG) fault, Line-To-Line (LL) fault, Double-Line-To- Ground (LLG) fault, One conductor open fault, and two Conductors open fault.	**06**
5	**Power System Stability:** Introduction, dynamics of a synchronous machine, power angle equation, power angle curve, simple systems, steady state stability, transient stability, equal area criteria, numerical solution of swing equation, factors affecting transient stability	**06**
6	**HVDC and FACTS** Transmission Systems: DC Versus AC, HVDC technology, Configuration of HVDC Converter Stations, different HVDC projects, FACTS Technology , Basic Types of FACTS Controllers FACTS technology and basic types of FACTS controllers employing AI techniques for adaptive voltage regulation, power flow control, and system stability enhancement. (Add another topic)	**06**

References -

Text Books:

- Grainger John J and W D Stevenson, Power System Analysis, Tata McGraw Hill
- I. J. Nagrath, D. P. Kothari, Modern Power System Analysis, Tata McGraw Hill

Reference Books:

- J. D. Glover and M. Sharma, Power System Analysis and Design, Brooks/ Cole Publishing.
- C. L. Wadhwa, Power System Analysis, New Age International
- T. K. Nagsarkar and M. S. Sukhija, Power System Analysis, Oxford university Press

Rajarambapu Institute of Technology Electrical Department Rajaramnagar

Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class:-**T.Y. B. Tech.**	Semester- **V**
Course Code: **EE313**	Course Name: **Feedback Control System**

L	T	P	Credits
3	-	-	3

Course Description:
The course Control Systems, is the study of the analysis and regulation of the output behaviors of dynamical systems subject to input signals. Many engineering disciplines viz. electrical, mechanical, chemical, manufacturing, aerospace and biomedical uses tools and concepts of control engineering. This course focus on the fundamental theories and design techniques for linear time-invariant systems' feedback controllers. The course provides techniques to represent the physical systems into mathematical model and then analyze using time-domain & frequency domain. It also introduces the modern control theory technique.

Course Learning Outcomes:
After successful completion of this course, students will be able to:
1. Develop mathematical models of physical systems using transfer function representation.
2. Analyze time-domain response characteristics and steady-state performance of control systems.
3. Determine stability of linear control systems using algebraic and Root locus techniques.
4. Apply Bode and Nyquist methods to determine the frequency-domain behaviour of control systems
5. Apply state-space methods to model and analyze multi-input multi-output (MIMO) systems.

Prerequisite: Engineering mathematics – Differential equation, Laplace transform, Z-transform; Signals and Systems; Electrical Circuit Analysis.

Course Content

Unit No	Description	Hrs
1	**Introduction to Control Systems & Intelligent Systems:** Introduction to control system. Block diagram and components of control system. Industrial Control examples. Role of AI in modern automation (smart manufacturing, EVs, robotics). Significance of Sensors and Actuators, Open loop control and closed loop control systems.	06
2	**Control System Representation:** Transfer function and Pole-Zero concepts. Mathematical representation of simple mechanical, electrical, thermal, hydraulic system. Block diagram representation and reduction. Representation with Signal flow graph and Mason's Gain formula. Introduction to System identification using data, black-box modelling.	06

3	**Time Domain Analysis:** Time response of first order, second order systems. Analysis of steady state error, Type of system and steady state error, Time response specifications. Effect of parameter variation on open loop and closed loop system response, sensitivity. Effect of feedback on system response, stability and disturbance.	**06**
4	**Stability:** Concept of stability, Effect of pole zero location on stability, Routh-Hurwitz criterion. Root Locus method for analysis of gain margin, phase margin and stability.	**06**
5	**Frequency Domain Analysis:** Concept of frequency domain behaviour, frequency domain performance specifications. Correlation between time domain and frequency domain specification. Bode Plot for analysing system in frequency domain. Polar Plot and Nyquist Analysis.	**06**
6	**State Space Approach:** Representation of system in state space, Converting transfer function model into state space model. Canonical representation, Eigen values, Solution of state equations, State Transition Matrix and its properties, Concept of State feedback control, controllability, Observability. Introduction to State estimation using data.	**06**

References -

Text Books:

- K. Ogata, Modern Control Engineering Prentice Hall of India
- Norman S. Nise Control system engineering, John Wiley and sons

Reference Books:

- I.J. Nagarath and M.Gopal, Control Systems Engineering, New Age Int. (P) Ltd.
- B.C.Kuo, Automatic Control Systems Tata Mcgrawhill Education
- M. Gopal, Control Systems: Principles and Design, McGraw Hill Education
- Yuriy P. Kondratenko, Vsevolod M. Kuntsevich, Arkadii A. Chikrii, Advanced Control Systems: Theory and Applications

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Syllabus of T.Y. B. Tech Electrical Engineering
To be implemented for 2024-28 Batch
Department of Electrical Engineering

Class:- **T. Y. B. Tech.**	Semester- **V**
Course Code : **EE315**	Course Name : **Microcontroller & Its Applications**

L	T	P	Credits
3	-	-	3

Course Description:
This course introduces 8051 microcontroller architecture, memory organization, and programming in Assembly and C. Students will learn I/O ports, timers, and interrupts while interfacing peripherals like LCDs, sensors, and motors. It also provides an overview of ARM Cortex and PIC architectures for electrical engineering applications. The course focuses on Embedded AI to create smart, real-time microcontroller-based systems.

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

1. Explain the architecture, memory organization, and functional blocks of the 8051 microcontroller.
2. Develop assembly and C language programs using the 8051 instruction set, addressing modes.
3. Implement I/O port programming, timers, counters, interrupts, and UART-based serial communication.
4. Interface input/output devices such as displays, ADC/DAC modules, relays, and motors using microcontrollers.
5. Compare the features of microcontrollers such as 8051, ARM Cortex and PIC for modern electrical applications.

Prerequisite: Analog and Digital Electronics, Computer programming.

Course Content

Unit No	Description	Hrs
1	**Introduction to Microcontrollers:** Overview of microprocessors and microcontrollers, Comparison of microprocessor and microcontroller, 8051 microcontroller architecture, pin configuration, I/O ports, internal memory organization and Applications of microcontrollers	06
2	**8051 Programming:** Instruction set, Addressing modes, Assembly and C language programming, Stack, Subroutines, Program structure, counters and delays.	06
3	**I/O Port Programming and Timers:** I/O port structure and programming, Bit manipulation techniques, Timers and counters: Modes, programming, and applications, Generating square wave, time delay	06

Rajarambapu Institute of Technology Electrical Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

4	**Interrupts and Serial Communication:** Interrupt structure and priorities, Programming external and timer interrupts, Serial communication: Basics of UART, Serial data transmission and reception using 8051	**06**
5	**Interfacing with Peripherals:** Interfacing LEDs, switches, 7-segment displays, Interfacing LCD (16x2), Keypad, ADC and DAC interfacing, Stepper motor and DC motor control and Relay interfacing	**06**
6	**Advanced Microcontrollers and AI-Based Applications:** Introduction to ARM Cortex and PIC microcontrollers; case studies on smart meter, solar charge controller, and automatic power factor correction and AI-based applications in electrical systems.	**06**

References -

Text Books:

- Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education
- Kenneth J. Ayala, 8051 Microcontroller: Architecture, Programming and Applications, Thomson publication

Reference Books:

- Ajay V. Deshmukh, Microcontrollers: Theory and Applications, Tata McGraw-Hill
- Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, Pearson Education

Rajarambapu Institute of Technology Electrical Engineering Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Syllabus of T.Y. B. Tech Electrical Engineering
To be implemented for 2024-28 Batch
Department of Electrical Engineering

Class:-**T. Y. B. Tech.**	Semester- **V**
Course Code: **EE3094**	Course Name : **Energy Storage Technologies**

L	T	P	Credits
2	--	--	2

Course Description:
This course introduces energy storage in modern power systems, covering key concepts, performance metrics, and mathematical models. It explores major technologies including mechanical, thermal, battery, and hydrogen storage, along with their efficiency, economics, and reliability for grid and stationary energy systems. Also, the course describes the advances in storage technology and its application in power systems.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Explain the energy storage as a structural unit of a power system.
2. Compare various energy storage technologies for power systems.
3. Apply hydrogen energy storage for power system applications.
4. Analyze the economics and reliability of energy storage systems.

Prerequisite: Basic Electrical Engineering, Power Systems.

Course Content

Unit No	Description	Hrs
1	**Introduction of Energy Storage:** Energy storage as a structural unit of a power system, definition of energy, power, requirement for energy storage, electricity storage services, and benefits, technical definition: capacity, depth of discharge and state of charge, "Round-Trip" efficiency under normal, ideal, and real condition, Mathematical model of storage, storage applications, and econometric model of storage.	04
2	**Energy Storage Technologies:** Flywheel energy storage (FES), pumped-hydroelectric storage (PHS), compressed-air energy storage (CAES), and supercapacitor energy storage system (SCESS). Comparison and application state-of-art including principle, function, and deployments.	04
3	**Thermal energy storage:** Thermal energy storage (TES) methods - Sensible TES, Passive and active systems. Importance of thermal stratification, Strategies to enhance thermal stratification - Latent TES Selection of phase change materials depending on the application. Types of storage systems by change of phase, Cold TES, and Seasonal TES Characteristics of heat storage materials.	04

4	**Battery energy storage:** Introduction, different types of battery energy storage, conventional batteries and flow batteries, basic concepts: lead-acid batteries, nickel-cadmium batteries, sodium-sulfur batteries, lithium-based batteries, flow battery energy storage system, and modeling of battery.	**04**
5	**Hydrogen-based energy storage system:** Introduction, structure of a storage system based on hydrogen, electrolysis of water, storage of hydrogen, conversion, efficiency considerations. Application: large stationary power plants, small stationary power units, fuel cells for transport, and hydrogen energy storage transportation applications.	**04**
6	**Economic and reliability of electric energy storage system:** Electric energy storage economics, cost analysis, investment, and operation cost analysis of electric energy storage, reliability in power energy system, grid-reliability calculation, storage-system reliability, Techno-economic analysis of energy storage systems using reversible fuel cells and rechargeable batteries.	**04**

References -

Text Books:

- A. Ter-Gazarian, Energy Storage for Power System, Peter Pereginus Ltd. London.
- Alfred Rufer, Energy Storage System and Component, CRC Press.
- Francisco Diaz-Gonazalez, Andreas Sumper, Energy Storage in Power System, Wiley.

Reference Books:

- Luisa F. Cabeza, Advances in Thermal Energy Storage Systems: Methods and Applications, Woodhead Publishing.
- Christopher D. Rahn and Chao-Yang Wang, Battery system engineering, Wiley.
- Frank S Barnes, John G Levine, L, Large Energy Storage System handbbok, CRC Press.

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class:-**T. Y. B. Tech.**	Semester- **V**
Course Code : **EE3114**	Course Name : **Restructured Power System**

L	T	P	Credits
2	-	-	2

Course Description:
This course focuses on the fundamental concepts of power system deregulation and electricity market operations. It covers key topics such as open access, pricing mechanisms, competitive market structures, and system reliability in a deregulated environment. The course explains the role of the Independent System Operator (ISO) in various market models, along with generation scheduling, bidding strategies, market clearing mechanisms, congestion management, and ancillary service management. The course also introduces applications of Artificial Intelligence (AI) in electricity markets

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

1. Identify new dimensions associated with the power system and its economics.
2. Compare the various operating mechanisms of conventional and restructured power system.
3. Interpret various aspects of power markets and market architecture.
4. Propose ancillary services and bidding strategies in power sectors

Prerequisite: Fundamentals of power systems, Fundamentals of power system economics

Course Content

Unit No	Description	Hrs
1	**Reforms in Indian power sector:** Introduction to various institutions in Indian Power sector: Ministry of Power, state and central governments, Load dispatch centers, Regulatory commissions, Power Exchanges and their roles; The availability-based tariff (ABT), The Electricity Act 2003,Power Market, Power Trading	04
2	**Restructuring of Power Industry:** Reasons for restructuring of power industry; restructuring process, Entities involved, deregulation versus restructuring, Role of the Independent System Operator; Market participation issues; Unit Commitment in Deregulated Environment.	04
3	**Fundamentals of Economics:** Consumer behavior, Supplier behavior, Total utility and marginal utility Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Global welfare, and Deadweight loss. applications of Artificial Intelligence (AI) in electricity markets	04

4	**Transmission Congestion Management and Pricing:** Transfer capability, Available transfer capability, Total transfer capability. Effects of congestion, Importance of congestion management, Classification of congestion management methods, Transmission pricing methods	**04**
5	**Ancillary Service Management:** Type and Classification of ancillary services, Ancillary Services, Management in various countries; Sources of reactive power, Black start capability service, Provisions of ancillary services, Markets for ancillary services	**04**
6	**Market power and generators bidding:** Attributes of a perfectly competitive market, Imperfect competition, Electricity markets under imperfect competition Monopoly, Oligopoly, Sources of market power, Effect of market power, Identifying market power, role of demand side bidding, Introduction to optimal bidding by a generator company. Bidding strategies.	**04**

References -

Text Books:

- Kankar Bhattacharya, Math H.J. Boller, JaapE. Daalder, Operation of Restructured Power System, Klumer Academic Publisher.
- Fundamentals of Power System economics Daniel Kirschen and Goran Strbac, John Wiley & Sons Ltd.
- Mohammad Shahidehpour, and Muwaffaq alomoush, Restructured Electrical Power Systems, Marcel Dekker Inc.

Reference Books:

- Loi Lei Lai; Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England.
- NPTEL Cource-Restructured Power Systems, A. R. Abhyankar, S. A. Khaparde, Available: http://nptel.iitm.ac.in/courses/108101005/:

Class:-**T. Y. B. Tech.**	Semester- **V**
Course Code: **EE3134**	Course Name : **Digital Signal Processing**

L	T	P	Credits
2	-	-	2

Course Description:
The course covers theory and methods for digital signal processing including basic principles governing the analysis and design of discrete-time systems as signal processing devices. Course starts from the basic concepts of discrete-time signals and proceed to learn how to analyze data via the Fourier transform, how to manipulate data via digital filters and how to convert analog signals into digital. It also includes, review of discrete-time linear, time-invariant systems, Fourier transforms, Z-transforms, digital filter designs and fast Fourier transform (FFT) algorithm.

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

1. Formulate and analyze discrete-time signals and systems.
2. Apply Z-transform and spectral techniques for signal analysis.
3. Construct signals using Discrete-Fourier Transform (DFT) and FFT algorithms.
4. Design digital filters for signal conditioning in engineering applications.
5. Interpret DSP techniques in modern applications including data-driven and intelligent signal processing systems.

Prerequisite: Engineering mathematics, signals & systems, control systems.

Course Content

Unit No	Description	Hrs
1	**Discrete time signals and systems:** DSP system, properties, types of systems, Interconnection of DSP systems, Recursive and Non-recursive system, some elementary signals. Signals as data representations in AI systems. Role of DSP in data acquisition for Machine Learning.	04
2	**Z-Transforms for discrete signals:** Z-transforms overview, Region of Convergence, Properties of Z-transform for causal signals, Interpretation of stability in z-domain, Inverse Z-transforms. Applications of Z-transforms.	04
3	**Discrete Fourier Transform:** Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform (FFT) Algorithm, Fast convolution signal segmentation (overlap save algorithm overlap-add algorithm), Parseval's Identity, Implementation of Discrete-Time Systems. Spectral features used in AI.	04
4	**Design of IIR Digital Filters:** Impulse Invariant Technique, Bilinear transformation, Filters - Butterworth, Chebyshev, Low-pass, Band-pass, Band-stop, and High-	04

	pass. Pre-processing using filters for AI models.	
5	**Design of FIR Digital filters:** Window method, Park-McClellan's method. Low-pass, Band-pass, Band stop and High-pass filters. Effect of finite register length in FIR filter design.	**04**
6	**Digital signal processors:** Applications of Digital Signal Processing, Selection of a processor; Architecture of TMS 320CXX; Addressing modes; Applications. DSP processors vs AI accelerators, Real-time intelligent signal processing.	**04**

References -

Text Books:

- J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall.
- P. Ramesh Babu, Digital Signal Processing, Scitech Publisher

Reference Books:

- A.V. Oppenheim, R. W. Schafer, Discrete Time Signal Processing, Prentice Hall
- L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall.
- S. K. Mitra, Digital Signal Processing: A computer-based approach, McGraw Hill

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class:- **T.Y. B. Tech.**	Semester-V
Course Code: **EE3154**	Course Name: **Electrical Utilization and Traction**

L	T	P	Credits
2	--	--	2

Course Description:
This course is designed to provide students with a comprehensive understanding of electrical utilization and traction systems, particularly in the context of electric heating for industrial application, electrical circuits for refrigeration and air conditioning, electrical traction systems and drives. The course will cover both theoretical principles and applications related to the efficient utilization of electrical energy for various purposes, with a focus on traction systems for transportation.

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

1. Analyze electric heating for industrial application.
2. Demonstrate electric welding for industrial application.
3. Inspect electric circuits for refrigeration and air conditioning.
4. Evaluate the use of various process control techniques.
5. Summarize electrical traction systems and drives.

Prerequisite: Basic Electrical, Power System, Electric Machines, Electric Drives

Course Content

Unit No	Description	Hrs
1	**Electric Heating:** Advantages of electrical heating, Heating methods, Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, Induction heating; principle of core type and coreless induction furnace, Electric arc heating, direct and indirect arc heating, construction. AI Applications in Electric Heating	04
2	**Electric Welding:** Advantages of electric welding, Welding methods, Principles of resistance welding, types – spot, projection seam and butt, welding and welding equipment used, Principle of arc production, electric arc welding, characteristics of arc, carbon arc, metal arc, hydrogen arc welding, welding of aluminum and copper. AI Applications in Electric Welding	04
3	**Electrical Circuits for Refrigeration and Air Conditioning:** Electrical circuits used in Refrigeration, Air Conditioning and Water Coolers, Principle of air conditioning, vapor pressure, refrigeration cycle, eco-friendly refrigerants, Description of Electrical circuit used in refrigerator, air conditioner and water cooler.	04

4	**Electrolytic Processes:** Need of electro-deposition, Laws of electrolysis, process of electro deposition - clearing, operation, deposition of metals, polishing, buffing, equipment and accessories for electroplating, factors affecting electro deposition Principle of galvanizing and its applications, Principle of anodizing and its applications.	**04**
5	**Electric Traction Systems:** Types of electric traction, systems of track electrification Traction mechanics-types of services, speed time curve and its simplification, average and schedule speeds Tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence	**04**
6	**Electric Traction Drives:** Salient features of traction drives, AC traction drives, series – parallel control of dc traction drives (bridge transition) and energy saving power electronic control of dc and ac traction drives diesel electric traction, Metro traction systems. AI Applications in Electric traction drives.	**04**

References -

Text Books:

- H. Partab, Dhanpat, Art and Science of Utilization of Electrical Energy, Rai & Sons.
- Dr. S. L. Uppal, Electrical Power, Khanna Publishers.
- E.O.Taylor , Utilisation of Electric Energy, Orient Blackswan

Reference Books:

- J. S. Sivanagaruju, Generation and Utilization of Electrical Energy, Pearson.
- J. B. Gupta, Utilization of Electrical Energy, Kataria Publications
- H. Partab, Modern Electric Traction, Dhanpat Rai & Co

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414 K.E.S.

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Syllabus of T.Y. B. Tech Electrical Engineering
To be implemented for 2024-28 Batch
Department of Electrical Engineering

Class:- **T.Y. B. Tech.**	Semester- **V**
Course Code: **OE341**	Course Name: **Energy Audit and Management**

L	T	P	Credits
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.

Rajarambapu Institute of Technology Electrical Engineering Department Rajaramnagar

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To be implemented for 2024-28 Batch
Department of Electrical Engineering

Class:- **T. Y. B. Tech.**	Semester- **V**
Course Code: **OE343**	Course Name: **Data Science**

L	T	P	Credits
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**
Course Code:- **OE361**	Course Name: **Object Oriented Modeling and Design**

L	T	P	Credits
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,

1. Identify object classes and build the domain model using advanced concepts in object, dynamic and functional modeling.
2. Apply different object-oriented design techniques.
3. Design models using UML diagrams for software systems: use case, class, sequence, collaboration, activity, state chart diagrams, component and deployment.
4. Design software systems using open source and advanced modeling tools.
5. 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** Preview of OMT technology, Impact of an object oriented approach, Analysis, Systemdesign with examples, combining models, Designing models, ComparingMethodologies usingstructured analysis and design.	**06**
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 chartdiagrams, Case Study on use case, interaction, activity and statechart diagrams.	**06**
6.	**Architectural Modeling using UML:** - Components, Deployment, Collaboration, Patterns and Frame works, Componentdiagrams 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, JeamsRambaugh, Ivar Jacotson, "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:- **T.Y. B.Tech.**	Semester- **V**
Course Code: **OE3104**	Course Name: **Network Administration**

L	T	P	Credits
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,

1. Explain the fundamental concepts of computer networking and their applications in industrial and organizational environments.
2. Apply IP addressing techniques and perform basic network configuration for connected systems and devices.
3. Demonstrate the configuration and management of common networking devices such as switches, routers, and wireless access points.
4. Analyze basic network security measures and safe communication practices in networked systems.
5. 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)	06
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.	06
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).	06
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.	06
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.	06
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.	06

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**
Course Code: **OE3381**	Course Name: **Disaster Management**

L	T	P	Credits
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,

1. Outline disaster and disaster management cycle.
2. Summarize disaster preparedness and response activities for various types of disaster.
3. Apply various advanced techniques for disaster management.
4. Examine role of various agencies in disaster management.
5. 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 waning, 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
3.	**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 Recovery, The Recovery Plan, Disasters as opportunities for development initiatives.	**06**
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.

Textbooks:

- 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,
1. Apply EIA methods to prepare a report.
2. Analyse the all projects by using Environmental Impact assessment tool.
3. Provide solution for decision making in Industrial Development Problem.
4. 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
Course Code : **OE347**	Course Name : **New Product Design & Development**

L	T	P	Credits
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:

1. Identify the new product opportunities and sources of new product ideas.
2. Elaborate the product life cycle and product design process.
3. Integrate the customer and end-consumer needs into design process.
4. Apply the concepts and tools like DFMA, VE and QFD in design process
5. Assimilate the various product characteristics to design a novel product
6. 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** Understanding customer needs, Voice of the customer, Gathering customer needs, Design Thinking (organizing and prioritizing needs), Product mission statement, Benchmarking and establishing product specifications	**06**
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 Flurscheim, Industrial Design in Engineering, the Design Council, London.

Class:-**T.Y. B. Tech**	Semester-**V**
Course Code: **OE349**	Course Name: **Non-conventional Energy Sources**

L	T	P	Credits
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:
1. Identify the need of requirement of renewable energy source
2. Summarize the various available energy sources.
3. Illustrate different technologies essential for conversion of renewable energy sources.
4. Evaluate the performance of energy conversion systems for maximum efficiency
5. Compare the various renewable energy technologies.
6. 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
Course Code: **OE3044**	Course Name: **Renewable Energy Sources**

L	T	P	Credits
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-

1. Explain fundamental knowledge of various renewable energy sources and their importance.
2. Describe the working principles, technologies, and applications of renewable energy systems.
3. Analyze the environmental impact and economic feasibility of renewable energy solutions.
4. 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:

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

Reference Books:

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

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Class: **T.Y. B.Tech.**	Semester-**V**
Course Code: **OE363**	Course Name: **Robotics Engineering & Applications**

L	**T**	**P**	**Credits**
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-

1. Explain various applications of robotics in industry and society.
2. Describe the concept of automation, robot integration, and their role in Industry 4.0.
3. Investigate the use of robots in healthcare, agriculture, defence, service, and space exploration.
4. 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

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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:

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

Reference Books:

- Groover, M. P. – Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill.
- Siciliano, B., Khatib, O. – Springer Handbook of Robotics, Springer.
- 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,

1. Recognize various automation technologies in manufacturing and process industries.
2. Select various automation tools and methods in the manufacturing industry.
3. Implement various control and automation methods in process industries.
4. 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
- Webb, John W. Programmable Logic Controllers: Principles and Application, Fifth edition, Prentice Hall of India, New Delhi.
- Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, ISA Publication.
- Bolton, "Programmable Logic Controllers" Newnes.

Class: - **T.Y. B. Tech**	Semester- **V**
Course Code: **OE355**	Course Name: **Cyber Physical System**

L	**T**	**P**	**Credits**
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

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K.S. Rajarambapu Institute of Technology

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:

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

Reference Books:

- Guido Dartmann, Houbing song, Anke schmeink, "Big data analytics for Cyber Physical System", Elsevier.
- Houbing song, Danda B Rawat, Sabina Jeschke, Christian Brecher, "Cyber Physical Systems Foundations, Principles and Applications", Elsevier.
- Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press.
- 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:
1. Explain the concepts of network connected embedded devices.
2. Identify and summarize different components required for IOT applications.
3. Analyse the system through Data Analytics tools.
4. 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

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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**
6.	**Domain specific IOT** Home automation, Cities, Environment, Agriculture, Health and lifestyle.	**06**

References-

Text Books:

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

Reference Books:

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

Class: - **T. Y. B. Tech**	Semester-**V**
Course Code: **OE359**	Course Name: **Drone Technology**

L	T	P	Credits
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:
1. Elaborate drone technology.
2. Explain fundamentals and design principles of UAV.
3. Discuss the wide range of applications of drone.
4. 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** 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.	**06**
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:

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

Reference Books:

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

Class:-**T.Y. B. Tech**	Semester-**V**
Course Code: **OE351**	Course Name: **Hydrogen and Fuel Cell Technology**

L	T	P	Credits
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,
1. Choose proper energy storage systems hydrogen and applications
2. Explain the different types of fuel cell technologies, fuels and membrane used in it
3. 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 electrolyzer: 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 borads 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

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5.	**Membranes &Fuels for Fuel Cells** Membranes: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments. 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.	**06**
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: **T.Y.B. Tech.**	Semester-**V**
Course Code: **CEMD301**	Course Name: **Infrastructure Engineering**

L	T	P	Credits
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:
1. Apply the knowledge of geometric design in road construction.
2. Identify the quality parameters of pavement materials and various methods of road construction.
3. Discuss the various aspects of airport engineering.
4. Explain design parameters of railway engineering and it's component parts.
5. Summaries the different off shore structures for dock and harbors.

Prerequisite: Physics

Course Content

Unit No.	Description	Hrs
1	**Highway Planning** Introduction: Classification of roads, Brief history of road development in India, Present status of roads in India, NHA1, NHDP, PMGSY, MSRDC; Geometric Design of Highways: Terrain classification, Design speed. Highway cross-section elements, Sight distance, Overtaking sight distance, Intersection sight distance;	06
2	**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
3	**Highway Construction** Types of Pavement (Flexible and Rigid); Types of Roads: WBM, WMM, DBM, SDBC, SMA, PQC, DLC; Highway Drainage: Necessity, sub surface and surace drainage; PPP in Transport Sector	06

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4	**Airport Engineering** Introduction: Advantage and limitation of air transportation, Aircraft component parts and characteristics, Importantterms in Airport planning, 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.	**06**
5	**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**
6	**Dock and Harbor Engineering:** Introduction, Planning and layout of ports, Classification, Site Selection, Breakwater, Jetties, Locks, Shore protection works.	**06**

References:

Text Books:

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

Reference Books:

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

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

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. 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,

1. Describe the fundamental elements of relational database management systems.
2. Design ER-models to represent simple database application scenarios.
3. Write SQL query to perform various operations on the database.
4. Analyze principle of integrity constraints, Hashing and Indexing on databases.
5. 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.

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous Campus

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, Structured Query Language (SQL): Data Definition Language, Data Manipulation Language, Aggregate functions, Set Operations.	**06**
3	**Integrity Constraints and Database Design** Domain Constraints, Referential Integrity, Functional Dependencies, Decomposition, Normalization: 1NF, 2NF, 3NF	**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	**Basic of Transactions** 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. Crash Recovery: Failure Classification, Log-Based Recovery, Checkpoints.	**06**

References –

Text Books:

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

Reference Books:

- Ramez Elmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson/Addision wesley.

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K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class:-**T. Y. 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,

1. Describe behavior of dc machine.
2. Explain the working principle of 1-Phase and 3-Phase transformers.
3. Explain working of different induction motors.
4. Select the relevant electrical machines for different applications.
5. 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 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.	**06**
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:

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

Reference Books:

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

Class: - **T. Y. B. Tech.**	Semester-**V**
Course Code : **ECMD301**	Course Name: **Advanced Communication Systems**

L	T	P	Credits
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,

1. Explain the principles of antenna and wave propagation.
2. Understand basic antenna parameters and their types.
3. Discuss the evolution, requirements, and challenges of 5G communication systems.
4. Understand and compare various communication techniques.
5. 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

Rajarambapu Institute of Technology Electrical Engg. Department Rajaramnagar

6	**Communication Techniques** Fundamentals of Fiber Optics Communication, GSM, CDMA, LTE, Blue Tooth, WiFi, ZigBee, LoRA, RFID.	06

References -

Text Books:

- Constantine A. Balanis "Antenna Theory: Analysis and Design" Wiley Publication.
- John D. Kraus and Ronald J. Marhefka "Antennas and Wave Propagation" McGraw-Hill Publication.
- Theodore S. Rappaport "Wireless Communications: Principles and Practice" Pearson Publication.
- 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,

1. Describe the fundamental elements of relational database management systems.
2. Design ER-models to represent simple database application scenarios.
3. Write SQL query to perform various operations on the database.
4. Analyze principles of integrity constraints, Hashing and Indexing on databases.
5. 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:

- Abraham Silberschatz , Hank Korth and S. Sudarshan , "Database System Concepts", McGraw Hill Education.
- Ram Krishnan, Johanses Gehrke, "Database Management Systems", McGraw Hill Education.

Reference Books:

- J.D. Ullman, "Principles of Database Systems ", Galgotia Publications.
- Jio Wiederhold, "Database Design", McGraw Hill International.

Class: **T.Y. B. Tech.**	Semester-V
Course Code: **MEMD305**	Course Name: **Product Design Tools and Techniques**

L	T	P	Credits
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,

1. Explain the basic principles of engineering design.
2. Design products for ease of manufacturing and assembly.
3. Apply value engineering and concurrent engineering principles in product design.
4. Apply various prototyping techniques using reverse engineering and rapid prototyping.
5. 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 integrating mechanisms, forming of CE team. Teamwork: Interfacing of manufacturing and design, selection of key techniques and methodologies, selection of CE tools.	**06**
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: -

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

Reference Books:

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

Rajarambapu Institute of Technology Electrical Engg. Department Rajaramnagar

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Class: - **T.Y. B. Tech**	Semester-V
Course Code: **MCMD301**	Course Name: **Sensor and Instrumentation**

L	T	P	Credits
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,
1. Explain the fundamental principles of various sensors and transducers.
2. Analyze the characteristics, advantages, and limitations of different sensor types.
3. Select and integrate sensors into mechatronic systems for real-time data acquisition and control.
4. Apply appropriate signal conditioning techniques to improve sensor output accuracy.
5. 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:** Thermocouples, Resistance Temperature Detectors (RTDs), Thermistors, Infrared (IR) temperature sensors. **Position and Displacement Sensors:** Potentiometers, LVDT (Linear Variable Differential Transformer), Optical encoders, Inductive sensors.	06
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:

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

Reference Books:

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

Class: **T. Y. B. Tech.**	Semester- **V**
Course Code: **AIMD301**	Course Name: **Machine Learning**

L	T	P	Credits
3	-	-	3

Course Description:
The students will understand the basics of Machine Learning. They will learn to applydifferent machine-learning algorithms to various datasets.

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

1. Utilize machine learning techniques and understand the basic theory underlying machinelearning.
2. Articulate supervised, unsupervised and reinforcement learning.
3. Identify the basic concepts of learning and decision trees.
4. Utilize Bayesian techniques for problems appear in machine learning.
5. 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 Reasoning, Support vector Machines (SVM).	06
5	**Clustering Based Learning** Types of clustering, K-means clustering algorithm, Advantages and dis-advantages 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:

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

Reference Books:

- Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Tylor andFrancis 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,

1. Represent object using composite rotation matrix.
2. Apply spatial transformation to obtain forward and inverse kinematics.
3. Plan trajectories for the robot end effector.
4. Perform Jacobian analysis of serial manipulators.
5. 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 Matrix, conventional Jacobian, Screw-Based Jacobian, and Transformations of screw coordinates. Relationship Between Two Methods, condition number, singularity analysis.	06
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-

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

Reference Books-

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

Class: **T. Y. B. Tech.**	Semester-**V**
Course Code:**CEMD303**	Course Name: **Smart Cities and Sustainable Development**

L	T	P	Credits
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:

1. Develop a critical understanding of the different concept and ideologies of smart cities.
2. Analyse the different approaches toward planning and development of smart cities on global level.
3. Assess the existing state and approach of Smart city Mission in India.
4. Comprehend the concept of resilience and sustainable development and its measurement.
5. Evaluate the present status of sustainability and rating systems initiatives within the Indian context.

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 analysis of Smart City Concept:** 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 analysis of smart city development projects in India	04

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, 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:

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

Reference Books:

- Mora L., Deakin M., "Untangling Smart Cities", Elsevier Science.
- Dag R. Bennett, Diana Pérez-Bustamante Yábar, "Sustainable Smart Cities", Springer International Publishing.
- 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:

1. Demonstrate a comprehensive understanding of Python syntax, data types, and basic operations.
2. Make use of common Python libraries for data manipulation.
3. Implement lists, tuples, sets, and dictionaries for effective data handling.
4. 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

Rajarambapu Institute of Technology Electrical Engg Department Rajarammagar

05.	**File handling and Exception:** File handling syntax, read files, write/create files, delete files, handing 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		
Exp 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

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Rajarambapu Institute of Technology K.E.S. Rajaramnagar Autonomous 415414

References -

Text Books:

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

Reference Books:

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

Class:-**T.Y. B. Tech.**	Semester-**V**
Course Code : **EEMD305**	Course Name : **Electrical Technology**

L	T	P	Credits
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:
1. Demonstrate speed control methods of electrical machines.
2. Analyze performance of DC motor and induction motor for speed control applications.
3. Implement power electronic circuits for given application.
4. Measure electrical quantities using electrical and electronic instruments.

Prerequisite: Basic Electrical Engineering, Basic Electronics Engineering

Course Content

Unit No	Description	Hrs
01.	**Power Electronic Devices:** Power diode, BJT, Thyristor, MOSFET, IGBT: Structure, Symbol, Working Principle, Comparison.	02
02.	**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
03.	**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
04.	**Transducers:** Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Measurement of weight, speed, temperature, pressure and flow.	02
05.	**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

06.	**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

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

Class: - **T. Y. B. Tech.**	Semester-V
Course Code :**ECMD303**	Course Name :**Electronic Product Design**

L	T	P	Credits
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:
1. Elaborate product design processes.
2. Explain various aspects of PCB design.
3. Differentiate product-testing methods.
4. Create various documents for the product.

Prerequisite: Knowledge of basics analog and digital electronics and communication.

Course Content

Unit No	Description	Hrs
01.	**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
02.	**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
	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
03.	**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

04.	**Electronic Product Testing** 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.	04
05.	**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:

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

Reference Books:

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

Class:-**T.Y. B. Tech**	Semester-**V**
Course Code :**CIMD303**	Course Name: **OOP using Java**

L	T	P	Credits
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:
1. Explain the concepts and terminologies in object-oriented concepts and java programming language.
2. Apply object-oriented programming features and concepts for solving given problem.
3. Develop the java application using the collection framework to solve real word problem.
4. Apply the concepts exception handling to develop error free codes.
5. Utilize the concepts of package to develop efficient codes.

Prerequisite: Basic knowledge of C Programming

Course Content

Unit No	Description	Hrs
01.	**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
02.	**Introduction to Object-Oriented Programming** Features of object-oriented programming, Class and objects, Constructors, Method and constructor overloading, Nested classes.	02
03.	**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
04.	**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

05.	**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
06.	**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:

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

Reference Books:

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

Class: - **T.Y. B. Tech.**	Semester- **V**
Course Code: **MEMD307**	Course Name: **Design and Prototyping**

L	T	P	Credits
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,

1. Use CAD software to create detailed CAD models and designs.
2. Explain the workflow and settings for effective additive manufacturing.
3. Simulate the 3D printing process to identify and correct potential issues before actual printing.
4. 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

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

Reference Books:

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

Class: - **T.Y. B. Tech**	Semester-**V**
Course Code: **MCMD303**	Course Name: **Industrial Automation**

L	T	P	Credits
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:

1. Explore the architecture of PLC and its functions.
2. Execute the various instructions and logic in PLC.
3. Develop the PLC program for various applications.
4. Design and develop the SCADA, DCS system for various applications.

Prerequisite: Knowledge of fundamentals of Mechatronics

Course Content

Unit No	Description	Hrs
01.	**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
02.	**INSTRUCTIONS** Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters.	04
03.	**APPLICATION OF PLC** Traffic light control, 24-hour clock design, Automatic stacking process, temperature control, Automatic control of warehouse door,	04
04.	**NETWORKING OF PLC AND SCADA** Networking of PLCs-Data Communication-Fieldbus, PROFI bus, and Mod bus-OSI. Supervisory Control and Data Acquisition-Architecture.	04
05.	**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
06.	**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 -

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

Class: **T. Y. B. Tech.**	Semester- **V**
Course Code: **AIMD303**	Course Name: **Business Intelligence**

L	T	P	Credits
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.

- Articulate data pre-processing techniques.
- Analyze the data modeling required for business intelligence related tasks.
- Determine the role of statistical techniques in data analysis tasks.
- Identify big data analysis techniques.
- 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 in consistency es, 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

- James R Evans, "Business Analytics", Pearson.
- Jiawei Hanand Micheline Kamber, Morgan Kaufman, "Data Mining: Concepts and Techniques", ISBN 978- 81-312-0535-8.
- 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.
- Business Analytics for managers, Wolfgang Jank–exploring and discovering, Data Modeling.

Reference Books:

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

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Class: **T. Y. B. Tech.**	Semester: **V**
Course Code: **RAMD305**	Course**: Robot Programming**

L	T	P	Credits
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:
1. Explain Robot programming ecosystem.
2. Create reusable code for robot powered applications.
3. Design a custom robot using programming.
4. 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:

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

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Class:-**T. Y. B. Tech.**	Semester- **III**
Course Code : **SH3035**	Course Name : **Scholastic Aptitude I**

L	T	P	Credits
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.	**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	02
2.	**Percentage** Understand Conversion, Single change, Successive change, Product Stability, Applications of percentage.	02
3.	**Average, Allegations** Weighted average, Concept of average speed & allegation, Aplications of Average & mixture allegation.	02

4.	**Ratio & Proportion** Comparison of Ratio & fraction, Properties of Ratio & Proportion, Mean Proportion. Joint ratio	02
5.	**Profit & Loss** Same selling price different Cost Price, Same cost price different selling price Concept of false scale.	02
6.	**Simple interest -Compound interest** Basics, Difference between SI CI, Conversion Periods, Depreciation.	02
7.	**TRW, Pipes & Cisterns** Time, Rate and Work-Unitary Method, LCM Method, Calculation of remuneration. Pipes & Cisterns -Concept of negative work, LCM Method.	02
8.	**Blood Relations** Blood Relations -Symbols, generation of tree diagram, types of questions-pointing towards person, tree based, coded blood relation	02
9.	**Numerical Analogy** Basics, Relation between two numbers, numerical	02
10.	**Pattern, Step Completion** Image completion, Mirror images, Water images, input-Output	02
11.	**Series Completion** Types of series, Number series pattern, Letter series, Alphanumeric series,	02
12.	**Direction Sense** Basics, shadow based concept, Concept of local time zone (IST,GMT, Longitude, Latitude), Problems on local time difference, Coded direction sense	02
13.	**Coding Decoding** Letter-Letter, Letter- Number, Number-Number, Letter-Symbol, Mixed Coding,	02
14.	**Syllogism** Basics , Types of Statements, Different diagram for different statements, Types of Questions-Based on Conclusion, Based on Statements	02
	Total Hrs. (In the earlier syllabus of 42 hours we used to conduct around 20 practice problems for each topic. Now when 1 hour is reduced for the	28

	each chapter around 10 practice problems should be covered in each sessions)	

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- **V**		**L**	**T**	**P**	**Credits**
Course Code: **EE361**	Course Name: **Feedback Control System Lab**		-	-	2	1

Course Description:
This course deals with the implementation of fundamentals of classical and analysis which includes both the theoretical and practical aspects. This course provides hands on experience of using standard signals to test behavior of physical control systems and use of virtual environments to analyze system performance indices of feedback control systems via classical techniques such as root-locus and frequency-domain methods, also deals with design of LTI systems using various time domain and frequency domain techniques using real time hardware experiments and virtual environment like MATALB.

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

1. Test for responses of the mathematical model of different electromechanical systems for various standard inputs.
2. Evaluate time domain and frequency domain specifications of LTI systems
3. Examine the stability of LTI system using time-domain and frequency-domain techniques.
4. Simulate and design a simple controller for LTI systems
5. Analyze state space models of LTI systems

Prerequisite: Calculus and Transforms, Engineering Mathematics –III, Signals and Systems, Electrical Circuit analysis, Programming & Simulink with MATLAB.

Expt. No	Description	Hrs
1	Study of DC position control system and find its transfer function	02
2	Compute transfer function of AC Servomotor & draw speed-torque characteristics	02
3	Study the Synchro Transmitter-Receiver to find the error.	02
4	Calculate the Time domain specifications of first order and second order LTI system	02
5	Design a 1st and 2nd order system using RC/RLC circuit and with op-amp.	02
6	To Study the effect of feedback on 1st and 2nd Order Circuit using op-amp.	02

7	Analyze the system stability using Root-locus plot and verify the plot in MATLAB/Python environment	**02**
8	Analyze the system stability using Bode-plot and verify the plot in MATLAB/Python environment.	**02**
9	Develop state space model of the LTI system using MATLAB and convert SS2TF and TF2SS.	**02**
10	Test controllability and observability of a given LTI system	**02**
11	Closed loop speed control DC motor using PID controller using MATLAB	**02**
12	Study of inverted pendulum control system.	**02**

Class:- **T. Y. B. Tech.**	Semester- **V**
Course Code : **EE363**	Course Name : **Microcontroller Lab**

L	T	P	Credits
-	-	2	1

Course Description:
The Microcontroller Laboratory course is designed to provide hands-on experience and practical skills in working with microcontrollers, which are essential components in embedded systems. This course serves as a complement to theoretical knowledge gained in related microcontroller or embedded systems courses. Students will have the opportunity to apply their understanding of microcontroller architecture, programming, and interfacing through a series of laboratory exercises

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

1. Illustrate internal and external structure of microcontroller
2. Develop assembly language programs using the 8051 instruction set.
3. Apply internal timers, counters, and interrupts to execute accurate time-delay.
4. Analyze serial communication registers to implement data transmission and reception between systems.
5. Interface the memory and I/O devices to 8051 microcontroller.

Prerequisite: Analog and Digital Electronics, Computer programming.

Exp. No	Description	Hrs
1	Identify various blocks of 8051 microcontroller development board.	02
2	Write a Program for Addition, Subtraction, Multiplication, and Division of 8-bit and 16-bit Data	02
3	Write a Program to Find Sum of Series of 8-bit Data and Multiplication using Sequential Addition Method	02
4	Write a Write a Program to Find Largest and Smallest Number from a Given Data Series	02
5	Write a Program for Sorting Data in Ascending and Descending Order	02
6	Write a Program for Code Conversion (Hex to Decimal, ASCII to Decimal and Vice Versa)	02
7	Write a Program for generate delay using register.	02
8	Write a Program for transfer 8 bit data serially on serial port.	02
9	Write a Program for generate pulse and square wave by using Timer delay.	02
10	Interface display (LED/Seven segments/LCD) and keyboard with 8051 microcontroller	02
11	Interface ADC/DAC with 8051 microcontroller	02
12	Interface of Stepper Motor and DC Motor with 8051 microcontroller	02

Class:- **T.Y. B. Tech.**	Semester-V
Course Code: **EE359**	Course Name **Advanced Software Lab**

L	T	P	Credits
--	--	2	1

Course Description:
This laboratory course deals with advanced simulation software to cater the need of the students in the recent trends in the field of Electrical Engineering. The lab is important as it connects theory with real-world application, preparing students to contribute effectively to software projects. This lab course is designed for students aiming to succeed in software and testing companies. This hands-on laboratory course covers advanced programming, simulation design, Artificial Intelligence techniques, and modern testing tools using cutting-edge software platforms.

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

1. Analyze AC/DC converters circuits using software.
2. Make use of advance software programming and Simulink platform to solve different problems.
3. Analyze the power system analysis problem using advance simulation toolbox.
4. Develop power system network in advance software to solve power flow analysis problems.
5. Design power system network in advance optimization software to solve power systems problem.

Prerequisite: Analog and Digital Electronics, MATLAB Programming and Simulation, Power system, Power Electronics.

Expt. No	Description	Hrs
1	Study the effect of frequency on current in series RLC circuit with PSIM	02
2	Study the effect of time constant on circuit in series RL circuit with PSIM	02
3	Study of single-phase half wave uncontrolled rectifier with R load using PSIM	02
4	Study of the effect of a freewheeling diode for single phase half wave uncontrolled rectifier with RL load using MATLAB	02
5	Study of speed control of separately excited DC motor from armature side using MATLAB	02
6	Study of three phase uncontrolled rectifier with R and RL load using MATLAB	02
7	Study of Boost and Buck converter with RLC loads using MATLAB	02
8	Study and solve Gauss seidel method using MATLAB program.	02
9	Study of economic dispatch and unit commitment modelling using GAMS	02

10	Study of DCOPF and ACOPF modelling with CPLEX, MILP and MINLP solver using GAMS	**02**
11	Study of load flow using modeling with ETAP	**02**
12	Study of load flow using modeling with CYME	**02**
13	Study Optimal Power Flow using Particle Swarm Optimization	**02**
14	Study economic dispatch problem using AI optimization technique	**02**

Class:- **T. Y. B. Tech.**	Semester- **V**
Course Code: **EE369**	Course Name: **Mini Project-I**

L	T	P	Credits
-	-	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:

1. Identify and integrate the concepts of multiple foundational courses in designing an engineering artefact.
2. Design an engineering artefact by applying appropriate engineering principles, analytical methods, engineering calculations and modern engineering tools.
3. Develop and validate the engineering artefact through systematic implementation, testing, measurement and debugging.
4. Analyse the engineering performance by comparing predicted and measured results, and justify design decisions based on engineering fundamentals.
5. Prepare and present professional technical documentation demonstrating engineering reasoning, teamwork and effective communication.

Prerequisite: DC Machines and Transformer, Electrical Circuit Analysis, Power Transmission and Distribution Systems, Environmental Science, Electrical Maintenance and Troubleshooting, Analog and Digital Electronics, AC Machines, Electrical Measurement and Instrumentation.

Course Activities		
Week 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**

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Class:- **T.Y. B. Tech.**	Semester-**V**
Course Code: **EE365**	Course Name: **Industrial Training**

L	T	P	Credits
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Course Description:
At the end of fourth semester, each student would undergo four weeks Practical Training in an industry/ Professional organization / Research Laboratory/ Virtual Internship/online course with the prior approval of the Head of the department and submit a written typed report along with a certificate from the organization. The report will be evaluated during Semester-V by Department Program Committee (DPC) to be appointed by the Director.

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

1. Apply the Technical knowledge in real industrial situations.
2. Identify the industry problem on which they can do their final year project.
3. Formulate Technical reports/projects.
4. Demonstrate professional values and ethical standards.
5. Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

Prerequisite: Core courses of Electrical engineering, Professional Skill Development

1. EXPECTATIONS FROM STUDENTS:
Students are expected to:
1. Arrive at work as scheduled, ready to work, and stay for the agreed upon time
2. Present yourself in a professional manner at all times, including being appropriately dressed for your workplace
3. Communicate any concerns with your supervisor and the internship coordinator in a timely manner and respectfully
4. Demonstrate enthusiasm and interest in what you are doing; ask questions and take initiative as appropriate
5. Complete and submit assigned tasks by designated timelines.
6. Participate in assigned meetings at work and with the internship coordinator when you return to college.

2. INTERNSHIP REPORT -STUDENT'S DIARY/ DAILY LOG
The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the Circuit diagram & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the

Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

3. INTERNSHIP REPORT

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, TPO and Faculty Mentor.

The Internship report will be evaluated on the basis of following criteria:

i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.
v. Practical applications, relationships with basic theory and concepts taught in the course.

4. MONITORING & EVALUATION OF INTERNSHIP

The industrial training of the students will be evaluated in three stages:

a) Evaluation by Industry.
b) Evaluation through seminar presentation/viva-voce at the Institute.

a) Evaluation by Industry

The industry will evaluate the students based on the Punctuality, eagerness to learn, Maintenance of Daily Diary and skill test in addition to any remarks.

b) Monitoring/ Surprise Visit By TPO/ Staff/ Faculty Mentor

Faculty Mentor of the institutes will make a surprise visit to the internship site, to check the student's presence physically, if the student is found absent without prior intimation to the T & P Cell, entire training will be cancelled. Students should inform the TPO, faculty mentor as well as the industry supervisor at least one day prior to availing leave by email. Students are eligible to avail 1-day leave in 4 weeks and 2 days leave in 6 weeks of the internship period apart from holidays and weekly offs.

c) Evaluation through Seminar Presentation/Viva-Voce at the Institute

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria: • Quality of content presented. • Proper planning for presentation. • Effectiveness of presentation. • Depth of knowledge and skills. • Attendance

record, daily diary, departmental reports shall also be analyzed along with the Internship Report. Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build communication skills and confidence in students.

References -

- AICTE INTERNSHIP POLICY: GUIDELINES & PROCEDURES

Class: **T. Y. B. Tech.**	Semester - **V**
Course Code: **EE367**	Course Name: **MOOCS-II**

L	T	P	Credits
-	-	-	1

Course Description:
Online courses offered through platforms like NPTEL, SWAYAM, and NASSCOM provide opportunities to deepen the understanding of advanced electronics concepts and technologies to Electrical Engineering students. These courses focus on critical domains such as circuit design, electrical machines, power systems, control systems and emerging fields like electrical vehicles. 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 lifelong 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,

1. Explain advanced principles, methods, and technologies in various areas of electrical engineering.
2. Analyze electrical engineering problems using mathematical and engineering fundamentals.
3. Design solutions for electrical-based systems using modern engineering tools and platforms.
4. Apply programming and simulation techniques to develop and test electrical circuits and systems.
5. 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- **VI**
Course Code: **EE314**	Course Name: **Power System Protection**

L	T	P	Credits
2	-	-	2

Course Description:
Power System Protection is a core course in the undergraduate Electrical Engineering program. The course emphasizes fundamental and advanced protection techniques used in modern power systems. It covers the operating principles, construction, and performance characteristics of protective devices such as circuit breakers, relays, and fuses. The course also introduces microprocessor-based and digital protection systems, highlighting their features, advantages, limitations, and practical applications in ensuring reliable and secure power system operation.

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

1. Compare the different protective devices
2. Describe Relays for power system protection.
3. Identify the proper earthing system and selection of Lightening arrester
4. Explain digital relaying scheme

Prerequisite: Basic Electrical Engineering, Power System

Course Content

Unit No	Description	Hrs
1	**Protective Devices:** Insulators, Fuse, MCB, MCCB, ELCB, Switch fuse unit (SFU), Location of protective devices, Advantages, Disadvantages, Applications, Advanced protective devices.	04
2	**Protective Relays:** Definition, classification and application of and Relays, Current-time characteristics, Induction disc Relays, pick up value, current setting, Plug setting multiplier, Time multiplier setting, Static Relays. Advantages and disadvantages. Advanced protective relays	04

3	**Circuit Breakers:** Mechanism, types of circuit breakers- Oil circuit breaker, Air-circuit breaker, vacuum circuit breaker, SF6 Circuit breaker, HVDC circuit breaker, Rating of circuit breaker, Advantages and disadvantages, Advanced circuit breakers	**04**
4	**Power system equipment protection:** Transformer Protection- Different faults in transformer, Buchholz relay, differential relay, Generator Protection- Mertz prize protection, Stator and rotor protection, Transmission line protection - Distance relaying scheme and characteristics, Reactance, impedance and MHO relay, under reach, Overreach, Advanced techniques for equipment protection	**04**
5	**Earthing and Lightening Arresters:** Definition, Earthing procedure, Earthing Electrode, Earthing systems, Earthing testing, Applications, Lightening arresters-Rod gap, horn gap, MOA- characteristics, Surge absorber, advanced techniques for surge Protection.	**04**
6	**Digital Relays:** Microprocessor based- overcurrent relay, overvoltage relay and Impedance relay. Advantages of digital relaying, Numerical relay hardware-organization and facilities available in commercial numerical relays	**04**

References -

Text Books:

- Power system protection and switchgear, Badri Ram and Vishwakarma, Tata McGraw Hill publication
- Switchgear and Protection, Sunil S. Rao, Khanna Publishers

Reference Books:

- Power system Protection and Switchgear, Oza, Nair and Mehta, MCGrawHill
- Principles of Power system. V. K. Mehta, S. Chands Publication
- Power system protection and switchgear, B. Ravindranath, New Age international Publication
- An introduction to the digital protection of power system, Dr. Yesri Z. AI-Harbawi, Independently published

Rajarambapu Institute of Technology Electrical Department Rajaramnagar

Class:-**T. Y. B. Tech.**	Semester- **VI**
Course Code: **EE3044**	Course Name : **Power Electronics**

L	T	P	Credits
3	--	--	3

Course Description:
This course provides a comprehensive foundation in power electronic devices and converter circuits used for efficient control and conversion of electrical energy. It introduces the characteristics, switching behavior, and applications of modern semiconductor power devices such as diodes, SCRs, MOSFETs, and IGBTs.
The course covers detailed analysis, operating principles, and performance evaluation of major power converter topologies including AC–DC controlled rectifiers, DC–DC converters (choppers), and DC–AC inverters.

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

1. Explain power semiconductor devices based on working principle, structure and operating characteristics.
2. Estimate the performance parameters of phase-controlled converters for R, RL and RLE Load.
3. Analyze the performance of DC-DC converters with respect to configurations and control strategies.
4. Draw waveforms and circuits of single phase and three phase inverter.
5. Describe working principle and configurations of resonant converters and switch mode power converters.

Prerequisite: Analog Electronics, Electrical Circuit Analysis, Engineering Mathematics

Course Content

Unit No	Description	Hrs
1	**Power Devices:** **Power Diodes:** Introduction, Structure, V-I Characteristics, Reverse Recovery Characteristics, types, DIAC **Power Transistors** – BJT, MOSFET, IGBT: Structure, Static and Dynamic Characteristics, Transfer and Output Characteristics, IGCT	06
2	**Thyristor:** **SCR:** Structure, Two-Transistor Analogy, Turn-on Methods, V-I Characteristics, Switching Characteristics, Gate Characteristics, Ratings, Thermal Equivalent Circuit and Heat Sink Selection, Methods of Commutation. **TRIAC:** Structure and V-I Characteristic, Mode of Conduction	06

3	**AC-DC Controlled Converter:** Principle of phase control, Single phase half wave converter with R and RL load, effect of freewheeling diode, Single phase full controlled converter in mid-point and bridge configuration with R, RL and RLE load, Single phase semi converter, Three phase half wave converter with R and RL load, Three full controlled converter with R, RL load, Three phase semi converter, Dual converter	**06**
4	**DC – DC Converter:** Principle of step–down and step-up choppers, control strategies for chopper, chopper configurations and quadrants of operations, Buck, Boost and Buck-Boost converters	**06**
5	**DC-AC Converters:** Principle of inverter, PWM signal generation, Single phase half bridge and full bridge inverter, Voltage Source Inverter, Three phase- six-step inverter in 120 and 180-degree mode, Current Source Inverter	**06**
6	**Advanced Power Electronics Converters:** **Resonant Converters:** Introduction, need of resonant converters, classification of resonant converters, concept of soft switching **Switched Mode Power Conversion:** Half bridge and full bridge converters, control circuits for converters and PWM techniques.	**06**

References -

Text Books:

- P. S. Bimbhra, —Power Electronicsǁ, Khanna Publishers, New Delhi.
- M. H. Rashid, "Power Electronics", PHI, New Delhi.

Reference Books:

- Power Electronics - P.C. Sen, Tata McGraw - Hill Publishing.
- Power Electronics – Ned Mohan, Tore D. Udeland, William P. Robbins – Wiley publications.
- Power Electronics – M. D. Singh & K. B. Kanchandhani, Tata McGraw – Hill Publishing Company.

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class:- **T.Y. B. Tech.**	Semester-**VI**
Course Code: **EE316**	Course Name: **Research Methodology**

L	T	P	Credits
2	--	--	2

Course Description:
The course introduces research methods as students apply to the higher education and their field of study. It gives an overview of research methodology including basic concepts employed in quantitative and qualitative research methods. The course covers all the conceptual and methodological issues that go into successful conduction of research. That includes philosophy of science, the methodological issues in measurement, proposing and testing hypotheses, scientific communication and the ethical issues in the practice of science.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Explain the research process and the principle activities, skills and ethics associated with the research process.
2. Formulate a research problem
3. Assess and critique a published journal article.
4. Identify the components of a literature review process
5. Prepare an effective research article or proposal by following research ethics

Prerequisite: Engineering mathematics, statistics

Course Content

Unit No	Description	Hrs
1	**An Introduction to Research Methodology** Research – Meaning, Objectives, Motivation; Types of Research; Research approaches; Significance; Research Methods versus Methodology.	04
2	**Defining the Research Problem** Research Problem; Selecting the problem; Necessity of defining the problem; Techniques involved in defining the research problem.	04
3	**Research Design** Need for research design; Features of a good design; Significant terms related to research design; Different research designs.	04
4	**Hypotheses** Hypothesis – meaning; basic concepts related to testing of Hypothesis. Procedure for Hypothesis testing; Limitations.	04

5	**Literature Studies** Effective literature studies approaches, Plagiarism, Research ethics, Approaches of investigation of solutions for research problem, Data collection and analysis, interpretation, Necessary instrumentation.	**04**
6	**Interpretation and Report Writing** Interpretation – techniques; precautions. Significance of report writing; Steps involved in report writing; types of reports; Oral presentations	**04**

References -

Text Books:

- J Ranjit Kumar, Research Methodology: A Step-by-Step Guide for beginners, SAGE Publication.
- C. R. Kothari, Research Methodology – Methods & Techniques, New Age International Ltd., Publishers.

Reference Books:

- Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta Academic
- Creswell, J. W. (2022). Research design: Qualitative, Quantitative and Mixed Methods Approaches, Sage Publications.
- Shyama Prasad Mukherjee, A Guide to Research Methodology – An Overview of Research Problems, Tasks and Methods, CRC Press, Taylor & Francis Group.

Class:- **T. Y. B. Tech.**	Semester-**VI**
Course Code : **EE3064**	Course Name : **Electrical Energy Conservation and Auditing**

L	T	P	Credits
3	--	--	3

Course Description:
This course provides essential theoretical and practical knowledge about the energy conservation, energy management, approaches to energy conservation in industries, economic aspects of energy conservation and energy audit and measuring instruments in the commercial and industrial sectors.

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

1. Examine the principles of Energy Management and Audit
2. Apply mathematical tools to solve energy economics
3. Select energy-efficient electrical technologies for energy saving
4. Analyze energy-efficient Industrial technologies for energy saving
5. Select energy-efficient technologies for energy saving

Prerequisite: Power Systems, Electrical Machines, Applied thermal ,hydraulic engineering

Course Content

Unit No	Description	Hrs
1	**Basic Principles of Energy Audit:** Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit. ECA 2001. Designated consumers and PAT scheme. Introduction: AI in Energy Auditing and Management.	06
2	**Energy Management and Audit:** Definition, energy audit, need, types of energy audit and approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies optimizing the input energy requirements, fuel & energy substitution, energy audit instruments	06
3	**Energy Management and Economics** Economics Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment .	06

4	**Energy Efficiency in Electrical Systems** Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement benefits, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	**06**
5	**Energy Efficiency in Industrial Systems** Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.	**06**
6	**Energy Efficient Technologies in Electrical Systems** Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	**06**

References -

Text Books:

- Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1 to 4, (available online)
- W.R. Murphy, G. Mckay Butter worth, Energy management, Heinemann Pub.
- Paul O'Callaghan, Energy management, McGraw Hill Book company

Reference Books:

- John .C. Andreas, Marcel Dekker, Energy efficient electric motors Inc Ltd.
- Amit kumar Tyagi, Hand book on Energy Audit and Management, TERI (Tata Energy Research Institute).

Class:-**T. Y. B. Tech.**	Semester- **VI**
Course Code : **EE318**	Course Name : **Battery Management Systems**

L	T	P	Credits
3	--	--	3

Course Description:
The purpose of this course is to provide a basic understanding of battery management systems. This course focuses on lithium-ion cell, Lithium-Polymer battery and BMS. In addition, this course provides a foundation in battery estimation and battery testing terminology. This course deals with function of battery-management-system requirements as needed by various applications.

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

1. Discuss BMS for various applications.
2. Compare various batteries for specific applications
3. Illustrate battery parameters and battery testing
4. Explain battery management methods for a given system
5. Illustrate thermal management and aging of batteries for electric vehicles.

Prerequisite: Power electronics, Control Systems.

Course Content

Unit No	Description	Hrs
1	**Introduction to BMS:** General background on alternative energy sources and sustainability, Application Requirements for Batteries and BMS Electric Vehicle, Relevant R&D Indicators, Development Background of the Battery, Battery Management System, Functions of the Battery Management System, Topology of the BMS, Development Process of the BMS	06
2	**Advanced Batteries:** Li-ion batteries, Principle of operation, Battery components and design, cell and battery fabrications, Building block cells, battery modules and packs, battery modeling, types of batteries, Li-polymer batteries and applications Li-S battery, Li-Air battery, comparison of batteries.	06

3	**Battery Parameter Estimation:** Preliminary definitions, State of Charge Estimation, Classification of SOC estimation methods, SOC Modeling, Instantaneous SOC, Current Counting Method, Voltage Lookup Method. SOH Estimation, Classification of SOH, Estimation Methods, Parameterization for Environment and Aging, Capacity Estimation Based on SOC Estimation, Real-world issues pertaining to batteries. State of Power Estimation.	**06**
4	**Battery Testing:** Introduction to chargers and charging infrastructure and Battery swapping, Battery Test Platform, Charge and Discharge Test Equipment, Impedance Characteristic Test Equipment in Frequency Domain, Battery Test Process, Battery Test Data analysis, Constant current and constant voltage method, Introduction of Testing Standards.	**06**
5	**Battery Management Methods:** Fundamentals of battery management systems and controls, Topology of the BMS, Charging Protocols, Pulse Power Capability Dynamic Power Limits. Pack Management, Pack Dynamics, Cell Balancing, Regulations and Safety Aspects of High Voltage Batteries-Code and Standards.	**06**
6	**Thermal management and Aging of Batteries for EVs:** Motivation for battery thermal management, Heat sources, sinks, and thermal balance, Design aspects of thermal management systems, Operational aspects, Aging effects, Aging mechanisms and root causes, Aging of battery packs, Testing, aging, modeling, Diagnostic methods, Extension of battery lifetime.	**06**

References -

Text Books:

- Rui Xiong, Battery Management Algorithm for Electric Vehicles, Springer
- Christopher D. Rahn and Chao-Yang Wang , Battery Systems Engineering, John Wiley & Sons, Ltd.Publication
- Online NPTEL resource on Electric vehicles by Prof. Zunzunwala and others from IIT Madras.

Reference Books:

- Bruno Scrosati, Jürgen Garche and Werner Tillmetz, Advances in Battery Technologies for Electric Vehicles , Woodhead Publishing, Springer
- H. A. Kiehne, Battery Technology Handbook, Marcel Dekker, NYC
- M. Ehsani, Y. Gao, S. Gay, A. Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, NY.

Class:- **T.Y. B. Tech.**	Semester-**VI**
Course Code : **EE3104**	Course Name: **Advanced Control Systems**

L	T	P	Credits
3	--	--	3

Course Description:
This course provides comprehensive knowledge of advanced control system design and analysis. It covers state space techniques, pole placement and observer design. The course introduces model order reduction with optimization and PSO-based approaches. Stability analysis using eigenvalues and Lyapunov methods is discussed. It also explores digital control fundamentals, sampling effects, and stability evaluation using Jury test and bilinear transformation. An overview of advanced control strategies such as LQR and Sliding Mode Control is also introduced.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Design state feedback controller and observer for the system models.
2. Examine stability of the state space model.
3. Formulate and implement model order reduction using metaheuristic algorithms.
4. Analyze discrete time system.
5. Design and find the control law for finite-time LQR problems.

Prerequisite: Basic Control Systems Engineering, Mathematics- Differential Equation and Matrix Calculation

Course Content

Unit No	Description	Hrs
1	**State Space Design:** Review on state space representation, State Transition Matrix, Canonical Forms, Tests for controllability and observability for continuous time system. Effect of state feedback on controllability and observability, Design of State feedback control through pole placement. Full order observer and reduced order observer.	06
2	**Stability Analysis in state space:** Concept of eigen values and eigen vectors, Lyapunov Stability (Sylvester's criterion), Lyapunov Stability Analysis (stability criterion), Lyapunov Stability Analysis (Direct Method).	06
3	**Model Order Reduction:** Introduction to Model Order Reduction (MOR). Classical MOR Techniques. Optimization-Based Model Order Reduction. Introduction to Metaheuristic Optimization. PSO-Based Model Order Reduction. Performance Evaluation and Applications.	06

4	**Discrete Representation of Continuous Systems:** Basics of Digital Control Systems, Discrete representation of continuous systems, Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effect of sampling and quantization. Choice of sampling frequency. ZOH equivalent.	06
5	**Discrete time control system analysis:** Review of Z-transform, Pulse transfer function of close loop systems. Solution of discrete time systems, time response. Stability analysis of closed loop systems. Stability analysis using Jury test, bilinear transformation and root locus.	06
6	**Overview of Modern Controllers:** Optimal Control - Performance Index- Constraints;Problem formulation – Finite time Linear Quadratic regulator – Infinite time LQR system; Introduction to Sliding Mode Control	06

References -

Text Books:

- M. Gopal, Modern Control System Theory, New Age International Publishers, 2nd edition.
- B. C. Kuo, Automatic Control Systems, Tata Macgrawhill Education
- M. Gopal, Digital Control Engineering, New age international publication

Reference Books:

- K. Ogata Modern Control Engineering, Prentice Hall of India
- Stainslaw H Zak, Systems and Control, Oxford Press
- D. Subbaram Naidu, Optimal Control Systems, CRC Press, New York.

Rajarambapu Institute of Technology Electrical Engg. Department Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class:- **T.Y. B. Tech.**	Semester- **VI**
Course Code: **EE3124**	Course Name: **Application of Microcontrollers in Electrical Engineering**

L	T	P	Credits
3	--	--	3

Course Description:
This course explores deeper into complex microcontroller architectures, advanced programming techniques, and sophisticated applications. This course covers the fundamentals of programming and interfacing with PIC microcontrollers, which are a family of microcontrollers developed by Microchip Technology. It is designed for individuals who already have a strong foundation in microcontroller programming and want to deepen their knowledge for more sophisticated applications.

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

1. Illustrate internal and external structure of PIC microcontroller
2. Make a use of instruction set to write assembly language programming
3. Develop embedded C language program of modern PIC microcontrollers
4. Design PIC microcontroller interfacing circuit for various I/O device

Prerequisite: Microprocessor 8085, Microcontroller 8051, C programming

Course Content

Exp. No	Description	Hrs
1	**PIC Architecture:** PIC Architecture Comparison of CISC and RISC, RAM and Program memory organization, Program counters, Stack pointer, Bank Select Register, Status register, Data transfer instructions, Arithmetic and logical instructions.	06
2	**Assembly language programming:** Assembly language programming Addressing Modes for PIC 18 microcontroller, Branch instruction, CALL, RETURN, Bit addressable instruction. Assembly language programs I/O ports, SFR related to PORTs, I/O port programming.	06
3	**Embedded C programming:** Programming of PIC microcontroller in C Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations. I/O port programming in C, Delay programming.PIC 18 Timer 0 Programming in C	06

4	**Special Hardware features and Programming:** Timers required for CCP Applications, CCP module in PIC 18 microcontroller, Applications of CCP mode Generation of waveform using Compare mode of CCP module. Period measurement of a unknown signal using Capture mode in CCP module, Speed control of DC motor using PWM mode of CCP module	**06**
5	**Interrupt programming;** Interrupt Programming, Programming of Timer interrupts, Programming of External interrupts, Serial port programming. Interfacing of PIC18F458 8 bit model LCD(16x2)	**06**
6	**Interfacing of PIC Microcontroller:;** ADC, Programming of ADC using interrupts, Measurement of temperature and voltage Using PIC microcontroller. Interfacing DAC with PIC18F458, Interfacing of Electromechanical Relays and Opto-isolators.	**06**

References -

Text Books:

- Muhammad Ali Mazidi, Rolin McKinlay, and Danny Causey, PIC Microcontroller and Embedded Systems
- Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers: Principles and Applications

Reference Books:

- Martin P. Bates, Programming 8-bit PIC Microcontrollers in C: With Interactive Hardware Simulation
- Han-Way Huang, PIC Microcontroller: An Introduction to Software & Hardware Interfacing

Class: **T. Y. B. Tech.**	Semester: **VI**
Course Code: **OE3084**	Course Name: **Materials Management**

L	T	P	Credits
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** Layout of stores and warehouse, material handling in stores, physical control of stocks: obsolete, surplus and scrap management, accounting and record keeping of stores.	**06**
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.

Rajarambapu Institute of Technology Electrical Engg Department Rajaramnagar

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,

1. Identify the necessity and scope of operation research in decision making.
2. Formulate and solve linear programming problems using mathematical models and various optimization techniques.
3. Apply quantitative analysis methods to real-world decision-making scenarios in various industries.
4. 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.

Rajarambapu Institute of Technology Rajaramnagar Electrical Engg. Department

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class: **T. Y. B. Tech**	Semester: **VI**
Course Code: **OE358**	Course Name: **Plumbing (Water and Sanitation)**

L	T	P	Credits
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,
1. Explain the scope and purpose of building industry codes and standards
2. Explain different plumbing fixtures and its working.
3. Prepare layout of sanitary drain and storm drain.
4. Calculate water requirement and suggest layout for water supply.
5. 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,	06

	kitchen sinks, water coolers, drinking fountain, clothes washer, dishwasher, mop sink, overflows, strainers, prohibited fixtures, floor drains, floor slopes, 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**
Course Code: **OE372**	Course Name: **Industrial Safety**

L	T	P	Credits
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,

1. Analyze electrical and fire hazards by examining safe operating limits.
2. Evaluate the suitability of machine guards, hazardous-area electrical equipment, and high-pressure system.
3. Evaluate plant layout, ventilation, thermal comfort, and industrial lighting systems with reference to National Building Code.
4. Design safety and health management strategies incorporating ergonomics, occupational health, stress management.
5. 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, inspecting, repairing, hydraulic and nondestructive testing, hazards and control in mines.	06

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.

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Class:- **T.Y. B. Tech.**	Semester-**VI**
Course Code: **OE342**	Course Name: **Data Mining**

L	T	P	Credits
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,

1. Compare various conceptions of data mining as evidenced in both research and application.
2. Apply Classification and Clustering techniques for real time problems.
3. Characterize the various kinds of patterns that can be discovered by association rule mining.
4. Analyze web mining techniques for structured/un-structured data patterns.
5. 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** What is an Association Rule?, Methods to Discover Association Rules, A Priori Algorithm, Partition Algorithm, FP-Tree Growth Algorithm, Generalized Association Rule.	**06**
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**
Course Code: **OE368**	Course Name: **AI for Agriculture**

L	T	P	Credits
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,
1. Specify AI fundamentals, domains, and ethical aspects in agriculture.
2. Identify agricultural problems and apply data acquisition techniques.
3. Develop and evaluate AI models for agricultural applications.
4. Use statistical and generative AI methods for agri-analysis.
5. 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**

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**
Course Code: **OE3401**	Course Name: **Cyber Security**

L	T	P	Credits
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,
1. Describe fundamental terms in cybercrime legislation.
2. Compare various cyber-attacks & offences.
3. Analyze the Indian IT Act 2000 & amendments in the IT Act.
4. Asses social networks and security issues related to social media platforms.
5. Apply a strategy for creating awareness about cyber security for e-banking and legal issues among the social community.
6. 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 Ant-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.
- Henry A. Oliver, "Security in the Digital Age: Social Media Security Threats and Vulnerabilities ", Create Space Independent Publishing Platform, Pearson.

Reference Books:

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

Class:- **T.Y. B. Tech**	Semester-**VI**
Course Code: **OE364**	Course Name: **AI for Manufacturing**

L	T	P	Credits
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,

1. Describe Artificial Intelligence and its potential impact in manufacturing.
2. Apply AI techniques to solve problems in the manufacturing sector.
3. Demonstrate the use of AI techniques for robotic perception, environment understanding, and intelligent decision-making.
4. Illustrate key AI techniques used for fault detection and prediction in mechanical and industrial systems.
5. Explain the principles and techniques of demand forecasting in the context of manufacturing operations.
6. 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** Edge inferencing, edge inferencing in manufacturing, demand forecasting, solving problem in manufacturing using demand forecasting.	06
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.

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Class:- **T.Y. B. Tech.**	Semester-**VI**
Course Code: **OE348**	Course Name: **Information Technology Foundation Program**

L	**T**	**P**	**Credits**
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,

1. Explain fundamental problem-solving methods using logic, algorithms, and flowcharts to represent solutions systematically.
2. Develop C programs using control structures, arrays, strings, functions, and basic data structures to solve computational problems.
3. Analyze different programming paradigms, coding standards, optimization techniques, and debugging methods to improve program structure and efficiency.
4. Apply object-oriented principles such as abstraction, encapsulation, relationships, polymorphism, interfaces, and packages in program design.
5. Evaluate relational data models using ER diagrams, normalization techniques, and SQL queries to design efficient database systems.
6. 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**
Course Code: **OE366**	Course Name: **AI for Cybersecurity**

L	T	P	Credits
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:
After successful completion of the course, students will be able to,

1. Identify the Role of AI in Cybersecurity.
2. Analyze and Assess Security Risks in AI Systems.
3. Apply Security Best Practices to AI Development and Deployment.
4. 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.

Reference Books:

- 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 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,

1. Identify the role and key issues in the supply chain management.
2. Select appropriate SC strategies under given situations.
3. Design the inventory system and level at various locations in supply chain.
4. Specify the distribution and transportation requirements.
5. Develop appropriate strategic alliances for enhancing the performance of SC
6. 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** 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	**06**
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. Technopreneurers 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,
1. Identify, analyze & select business opportunity to suit his personality based on SWOT analysis.
2. Make market research & survey for selected business.
3. Prepare and apprise detailed Project Report.
4. Formulate plan for financial management of project.
5. 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 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**
Course Code: **OE3024**	Course Name: **Reliability Engineering**

L	T	P	Credits
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-

1. Explain the fundamental concepts and applications of Reliability Engineering.
2. Determine the reliability of simple and complex systems.
3. Apply different reliability allocation techniques for reliability analysis.
4. Apply the principles and techniques for reliability design and improvement.
5. Apply different techniques for reliability analysis of engineering systems.
6. 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** 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.	6
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:

- L. S. Srinath, Reliability Engineering, East-West Press.
- Elsayed A. Elsayed, Reliability Engineering, Addison Wesley.
- Kailash C. Kapur, Reliability Engineering.

Reference Books:

- Ebeling C.E., Introduction to Reliability and Maintainability Engineering", Overseas Press. Pvt Ltd.
- B.S.Dhillon, Maintainability, Maintenance and Reliability for Engineers, CRC Press.
- L.S.Srinath, Reliability Engineering, EWP.
- Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Springer,.
- Roger D Leitch, Reliability Analysis for Engineers: An Introduction, Oxford University Press.
- S S. Rao, Reliability Based Design, Mc Graw Hill Inc.
- E.E.Lewis, Introduction to Reliability Engineering, John Wiley and Sons.
- Basu S.K, Bhaduri, Terotechnology and Reliability Engineering, Asian Books Publication.
- Dr. A. K. Gupta, Reliability, Maintenance and Safety Engineering.
- John D. Musa, Software Reliability Engineering, Tata McGraw Hill.

Class: **T.Y. B.Tech.**	Semester-**VI**
Course Code: **OE362**	Course Name: **Flexible Manufacturing System**

L	T	P	Credits
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-

1. Apply the concepts to the development of FMS.
2. Discuss the control structure used in manufacturing systems.
3. Discuss the Scheduling & Loading of FMS.
4. Identify hardware and software components of FMS.
5. Summarize the concepts of Cellular Manufacturing.
6. 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 of JIT pull method, small lot sizes, work station loads, flexible work force, line flow strategy. supply chain management.	**06**
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:

- Shivanand H.K., Benal MM, Koti V, "Flexible Manufacturing System", New age international (P) Limited, New Delhi.
- Mikell P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", PHI.

Reference Books:

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

K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Syllabus of T.Y. B. Tech Electrical Engineering
To be implemented for 2024-28 Batch
Department of Electrical Engineering

Class: - **T. Y. B. Tech**	Semester-**VI**
Course Code: **OE344**	Course Name: **Supply Chain Analytics**

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 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,

1. Identify the role and key issues in the supply chain management.
2. Explain the important supply chain drivers and their significance in strategic planning.
3. Estimate the demand using suitable demand forecasting method.
4. Design the inventory system and level at various locations in supply chain.
5. Design the supply chain network using appropriate network design methodology for the given problem.
6. 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.

Class: - **T.Y. B. Tech.**	Semester- **VI**
Course Code: **OE346**	Course Name: **Mobile Robotics**

L	T	P	Credits
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 include1. 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,

1. Identify and explain the main components of a robot, including sensors, actuators, and control systems.
2. Solve forward and inverse kinematics problems for mobile robots.
3. Apply basic motion planning algorithms such as A* and Dijkstra's algorithm.
4. Apply Simultaneous Localization and Mapping.
5. 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:

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

Reference Books:

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

Class: **T. Y. B. Tech**	Semester: **VI**
Course Code: **OE352**	Course Name: **Image Processing**

L	T	P	Credits
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,

1. Explain different concepts and processes in digital image processing.
2. Apply different image processing operations on an image.
3. Analyze various operations on image using different tools.
4. Compare various filtering, enhancement, segmentation and classification techniques used in image processing.
5. 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, smoothening 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:** Shape representation, Feature space, Clusters and classification techniques, Supervised and Unsupervised classification, Basic algorithms: Boundary extraction, region filling, thinning and thickening, skeletons.	06

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:

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

Reference Books:

- R.C. Gonzalez & R.E. Woods, Digital Image Processing using MATLAB, Pearson.
- 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 & 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,

1. Develop a comprehensive understanding of fuzzy sets, operations, and their applications in problem-solving scenarios.
2. Solve problems related to relations and composition.
3. Design, implement various neural network architectures.
4. 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** 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.	**06**
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:

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

Reference Books:

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

Class:-**T.Y. B. Tech.**	Semester-**VI**
Course Code: **OE356**	Course Name: **Project Management**

L	T	P	Credits
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,
1. Explain concept of project Management.
2. Prepare project analysis.
3. Prepare technical appraisal of selected project.
4. Prepare financial appraisal of selected project.
5. 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: Technical Appraisal**	06

	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.

Reference Books:

- 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.

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Class: **T. Y. B. Tech**	Semester: **VI**
Course Code: **OE370**	Course Name: **AI for Sustainability**

L	T	P	Credits
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,

1. Explain fundamentals of Artificial Intelligence and Sustainability.
2. Analyze the potential and impacts of AI to address environmental, social and economic challenges.
3. Develop critical thinking skills for evaluating and comparing AI solutions in sustainable context.
4. Apply AI, IOT and other technologies to prototype sustainable solutions for 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** 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.	**06**
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:

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

Reference Books:

- 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.
- Klaus Schwab "The Fourth Industrial Revolution", Crown Publishing Group.
- Peter Dauvergne "AI in the Wild: Sustainability in the Age of Artificial Intelligence", MIT Press.
- Srikanta Patnaik, Siddhartha Bhattacharyya, Nilanjan Dey (Eds.), "Smart Intelligent Computing and Applications", Springer.

Class:- **T. Y. B. Tech.**	Semester- **VI**
Course Code: **OE3242**	Course Name : **Marketing For Engineers**

L	T	P	Credits
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,

1. Analyze market opportunities by evaluating customers, competitors, collaborators, the business environment, and the strengths and weaknesses of an organization.
2. Develop effective marketing strategies, including market segmentation, targeting, positioning, and the marketing mix, to achieve organizational objectives.
3. Design and implement marketing plans by integrating product, pricing, distribution, and promotional strategies to enhance organizational performance.
4. Evaluate the impact of marketing strategies on customer value, competitive advantage, and organizational profitability.
5. 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.	06
2	**Market Segmentation, Targeting & Positioning:** Basis for market Segmentation, Targeting, Positioning. Marketing Mix, Significance of competitive environment.	06

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.	**06**
4	**Pricing & Distribution:** Price determinants, policies, Methods. Channel Management, Channel conflict and resolutions.	**06**
5	**Promotion:** Promotion mix, Advertising, Media decisions, Sales Promotion, Personal selling, Managing Sales Force. Advertising Effectiveness.	**06**
6	**Strategy:** An Introduction, Dealing with competition, Porter's five force model, Strategy, Strategic Analysis & The Market Environment.	**06**

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.

Rajarambapu Institute of Technology Rajaramnagar Electrical Engg. Department

Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414 K.E.S.

Class: **T.Y.B. Tech.**	Semester-**VI**
Course Code **:CEMD302**	Course Name: **Environmental Engineering**

L	T	P	Credits
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 successful completion of the course, students will be able to:
1. Explain importance of water and wastewater analysis for various parameters.
2. Discuss impact of pollution on man, animal and plants.
3. Prepare layout of water and wastewater treatment process.
4. Design Water and Wastewater Treatment Plant.
5. Apply AI tools for impact of humans on environment.

Prerequisite: Basic knowledge of Environmental Science.

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; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.	06
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.

K.E. Society's
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Department of Electrical Engineering

Class: **T.Y.B. Tech.**	Semester-**VI**
Course Code **:CSMD302**	Course Name: **Artificial Intelligence**

L	T	P	Credits
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:
1. Explain fundamental concepts and applications of AI
2. Apply appropriate search techniques and heuristic methods to solve them efficiently.
3. Describe appropriate knowledge representation using logic inference.
4. Analyze the Planning and Understanding schemes for the goal stack.
5. Analyze Understanding, perception, constraint-based reasoning
6. 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	**06**
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).	**06**
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.	**06**
4	**Planning:** Planning problems and components, Goal stack planning, Nonlinear Planning using Constraint Posting, Hierarchical Planning, Partial order planning (introduction), planning in deterministic environments	**06**
5	Understanding: Level of interactions among components, understanding as a constraint satisfaction, Line labeling, The Waltz algorithm.	**06**
6	**Modern AI Applications**: AI applications: Healthcare, Finance, And Robotics, Autonomous systems, Case studies of AI systems, societal impact and ethics of AI.	**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.

References:

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

Class: **T.Y.B. Tech.**	Semester-**VI**
Course Code : **EEMD302**	Course Name: **Smart Grid**

L	T	P	Credits
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 gird, various distributed energy sources, smart metering and distribution automation equipment.

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

1. Summarize the concept and future of smart grid
2. Develop smart grid architecture
3. Compile various smart grid technologies
4. Identify communication and information technologies for smart grid
5. Elaborate distributed generation and storage technologies
6. Recommend smart metering and distribution automation

Prerequisite: Fundamentals of Power system.

Unit No	Description	Hrs
01.	**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**
02.	**Smart grid architecture:** 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.	**06**
03.	**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**
04.	**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**

05.	**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**
06.	**Smart metering & distribution automation:** Evolution of electricity metering, key components of smart metering, overview of the hardware used, communications infrastructure for smart metering and protocols for smart metering, equipment's used in smart grid - current transformers, voltage transformers, intelligent electronic device, bay controller, remote terminal units, components for fault isolation and restoration, fault location.	**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**
Course Code: **ECMD302**	Course Name: **Industrial Electronics**

L	T	P	Credits
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:
1. Identify basics Power Electronics devices and components.
2. Illustrate use of Power Electronics.
3. Develop PLC logic using ladder programming.
4. Analyze industrial electronics applications.

Prerequisite: Knowledge of basic electronics and programming.

Course Content

Unit No	Description	Hrs
01.	**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
02.	**Power Converters** AC-DC Converters (Rectifiers), DC-DC converters (choppers), DC-AC converter (Inverters), AC-AC Converters (1-phase, 3-phase) Cycloconverters	06
03.	**DC and AC Drives** Basic characteristics of DC motor, operating modes, DC motor control using choppers and rectifiers, Torque-speed characteristics of induction motor, speed control techniques of AC motor: stator-voltage, rotor resistance, and v/f control, basic equations, characteristics.	06
04.	**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
05.	**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

06.	**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:

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

Reference Books:

- M. D. Singh and K. B. Khanchandani, Power Electronics, TMH
- 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 asObjects, 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:

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

Prerequisite: Fundamentals of Computers

Unit No	Description	Hrs
01.	**Software Requirements, Analysis and Specification** Software requirement analysis and specification, problem analysis, Requirement Specification, Validation, effort estimation, risk management, software testing types	06
02.	**Software Process Models** Waterfall model, V model, Prototyping, Spiral model, Agile software development	07
03.	**Function-oriented Design** Design principles, module level concepts, Design notation and specification, structured design methodology, Verification	05
04.	**Structural Modeling using UML** Classes, Relationships, Common mechanisms. Diagrams, Class Diagrams, Interfaces, Types and Roles, Packages, Instances and Object Diagram	06
05.	**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

06.	**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:

- Pankaj Jalote, "An Integrated Approach to S/W Engineering", Narosa Publication House.
- Grady Booch, Jeams Rambaugh, Ivar Jacotson, "The Unified Modeling Language User Guide" (Addison Wesley)

Reference Books:

- Roger S. Pressman, "Software Engineering – Practitioner's Approach", TATA McGraw-Hill.

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

L	T	P	Credits
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,

1. Explain product positioning and branding strategies for new products
2. Analyse market trends and consumer behaviour to identify opportunities for new product development.
3. Develop pricing strategies and cost estimation techniques for new products
4. Explain the basics of intellectual property rights and patents in the context of new product development
5. Design distribution channels and sales strategies designed for anew products
6. Create effective marketing communication plans and launch strategies for new products.

Unit No	Description	Hrs.
01.	**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**
02.	**Market Analysis and Segmentation:** Conducting market research to identify opportunities and threats, Analysing market trends and consumer behaviour, Segmentation techniques for targeting specific market segments, Assessing market competition and differentiation strategies, Utilizing data analytics tools for market analysis	**06**
03.	**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**

04.	**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**
05.	**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**
06.	**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:

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

Reference Books:

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

Class: - **T.Y. B. Tech**	Semester-**VI**
Course Code: **MCMD302**	Course Name: **Industrial Robotics**

L	T	P	Credits
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,
1. Explain the basic concepts of Robots.
2. Select an end effector and sensor for application.
3. Explain drives and controls for robotic system.
4. 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:

- 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.
- Mikell P Groover, Industrial Robotics - Technology, Programming and Applications, McGraw Hill, 1986.
- Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010.

Reference Books:

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

Class: **T. Y. B. Tech.**	Semester-**VI**
Course Code: **RAMD302**	Course Name: **Industrial Automation & Control**

L	T	P	Credits
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 Outcomes:
After successful completion of the course, students will be able to-

1. Explain need, basic elements, and systems of industrial automation.
2. Develop PLC programming for various applications.
3. Discuss various material handling and identification technologies.
4. Explain basics of DCS and its interfacing.

Prerequisite: NIL

Course Content

Unit No.	Description	Hrs
01.	**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
02.	**Transfer Lines and Automated Assembly** Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications, Analysis of transfer lines with and without storage buffers. Assembly Automation: Types and configurations, Parts delivery at workstations.	06
03.	**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
04.	**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

05.	**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
06.	**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:

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

Reference Books:

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

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Class:-**T. Y. B. Tech.**	Semester- **IV**
Course Code : **SH3065**	Course Name : **Scholastic Aptitude II**

L	T	P	Credits
2*	-	-	-

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** Difference between P & C, Theorems of Permutation Theorems of Combination, Counting numbers of squares & rectangles, Triangle	03
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
	Total Hrs.	42

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**
Course Code : **EE3544**	Course Name : **Power Electronics Lab**

L	T	P	Credits
--	--	2	1

Course Description:
This laboratory course focuses on the practical study and experimental verification of power semiconductor devices and power converter circuits. It provides hands-on experience in observing the operating characteristics, switching behavior, and performance parameters of devices such as SCRs, MOSFETs, IGBTs, and power diodes.
The course emphasizes the practical implementation, testing, and analysis of various power electronic converters including AC–DC rectifiers, DC–DC converters (choppers), DC–AC inverters, and AC voltage controllers. Students will investigate the performance of these converters when connected to different types of loads such as resistive, and inductive.

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

1. Determine the operating characteristics of power semiconductor devices.
2. Demonstrate the performance of power electronic converters connected to resistive loads by observing and recording output waveforms.
3. Analyze the performance of power electronic converters based on measured output parameters.
4. Design suitable power electronic converter circuits for specific industrial or application-based requirements.
5. Perform simulation of power electronic converters using appropriate software tools and validate results with experimental observations.

Prerequisite: Analog Electronics Laboratory, Basic Electrical Engineering Laboratory

Course Content		
Expt. No	**Description**	**Hrs**
1	Plot V-I Characteristics of SCR	**02**
2	Plot Transfer and Output Characteristics of MOSFET	**02**
3	Plot Transfer and Output Characteristics of IGBT	**02**
4	Plot V-I Characteristics of TRIAC and DIAC	**02**
5	Implement 1-Phase Full Bridge Controlled Rectifier for Resistive Load	**02**
6	Implement 3-Phase Full Bridge Controlled Rectifier for Resistive Load	**02**
7	Implement 3-Phase Half Bridge Controlled Rectifier for Resistive Load	**02**

8	Simulation: 1- Phase Full Controlled Rectifier: Bridge and Mid-point Configuration	**02**
9	Simulation: 1- Phase Half Bridge Controlled Rectifier: Semi-converter	**02**
10	Simulation: 3- Phase Full Controlled Rectifier: Bridge Configuration	**02**
11	Simulation: 1- Phase Full Bridge Inverter.	**02**
12	Implement High Frequency Chopper Circuit using MOSFET	**02**
13	Demonstrate Multi-Quadrant operation of Chopper	**02**

Class:-**T. Y. B. Tech.**	Semester- **VI**
Course Code: **EE360**	Course Name: **Automation and Control Lab**

L	T	P	Credits
-	-	2	1

Course Description:
This Course offers an opportunity for the learners to have practical knowledge of the industrial automation and technologies. This laboratory course is to inculcate the practices followed in the automation industry along with the use of sensors and actuators. Programmable Logic Controller (PLC) is the main focus of this course and students are asked to develop the relay ladder logic (RLL) for the given problem statement. Also, other IEC programming languages are introduced to them. Study of SCADA, HMI and its applications also enhance their skills.

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

1. Design relay logic-based control system for the given applications.
2. Implement IEC based programming languages for various PLCs.
3. Develop Relay Logic Ladder for the real-time PLC based control applications.
4. Design SCADA based GUI system for the real time applications.
5. Develop GUI based monitoring system of the real time applications using HMI.

Prerequisite: Programming, Analog and Digital Electronics.

Expt. No	Description	Hrs
1	Study Hardware components and software related to PLC	02
2	Use IL, RLL, FBD IEC based programming languages for various applications	02
3	Implementation of PLC based logic gates and case studies.	02
4	Implementation of DOL starter with Latch (L) and Unlatch (U) coils and case studies.	02
5	Implementation of PLC based timer applications	02
6	Implementation of PLC based counter applications	02
7	Implementation of PLC based compare and math instructions	02
8	Study of SCADA based application.	02
9	Implementation of Analog PLC Operations.	02
10	Study of HMI based ON/OFF control.	02

Class:-**T. Y. B. Tech.**	Semester- **VI**
Course Code: **EE364**	Course Name: **Power System Protection Lab**

L	T	P	Credits
-	-	2	1

Course Description:
'Power System Protection' laboratory is offered as the core course in Electrical Engineering under graduate program. This course focuses on various techniques of protection system applied in power systems. This course deals with the practical performance, Hands on practice and panel demonstrations for power system protection schemes.

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

1. Compare the Electromagnetic, static and microprocessor based relays
2. Plot Current-time and voltage-time characteristics of relays.
3. Demonstrate faults on power system fault simulation panels
4. Plot the current time characteristics of Numerical relay

Prerequisite: Basic Electrical Engineering, Power System

Course Content		
Unit No	**Description**	**Hrs**
1	To demonstrate power system protection devices	**02**
2	To plot Current-Time characteristic of Fuse and MCB	**02**
3	To test Break down voltage (BDV) of solid insulator on high voltage test kit	**02**
4	To test Break down voltage (BDV) of liquid insulator on high voltage test kit	**02**
5	To plot Current-Time characteristic of Induction disc relay	**02**
6	To plot Voltage-Time characteristic of static overvoltage and under voltage relay	**02**
7	To plot Inverse Current-Time characteristics of Microprocessor based relay	**02**
8	To plot Definite Current-Time characteristics of Microprocessor based relay	**02**
9	To simulate fault on generator protection demo panel	**02**
10	To plot Current-Time characteristics of Numerical relay	**02**

Class: **T. Y. B. Tech.**	Semester: **VI**	**L**	**T**	**P**	**Credits**
Course Code: **EE366**	Course: **Minor Project**	--	--	**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:

1. Formulate and analyse an engineering problem by integrating knowledge from multiple engineering disciplines and relevant standards.
2. Design, develop and optimize an engineering system using appropriate engineering principles, analytical methods, software tools and experimental techniques.
3. Validate system performance through experimentation, testing and analysis, and recommend suitable design improvements based on engineering evidence.
4. Apply project management practices, engineering standards, sustainability, safety and professional ethics during project execution.
5. 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.	12
2	Concept generation, system requirements, engineering specifications, feasibility analysis, system architecture and implementation plan.	12
3	Detailed engineering design, modelling/simulation, engineering calculations, component/material selection and Review-I (Problem Definition & Design Review).	12

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