



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

B.Tech. in Mechanical Engineering with Multidisciplinary Minor





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 Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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	
ME2094	Mathematics for Mechanical Engineers	2	-	-	2	ISE	20	40	40	---	---
						UT1	15				
						UT2	15				
						ESE	50				
ME2114	Manufacturing Processes and Machine Tool	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			---	---
ME2134	Engineering Thermodynamics	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			---	---
ME2154	Engineering Mechanics	2	-	-	2	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			---	---
-	Multidisciplinary Minor- I	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			---	---
ME2174	Computer Programming C++ Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---	---	50	50
ME2314	Engineering Mechanics Lab	-	-	2	1	ISE	---	---	100	50	
ME2334	Machine Drawing Lab	-	-	2	1	ISE	---	---	50	50	
						ESE	---	---	50	50	
ME2354	Workshop Practice-I	-	-	2	1	ISE	---	---	100	50	
ME2374	Technical Aptitude-I	-	-	2	1	ESE	---	---	100	50	
-	Professional Skills Development and Foreign Languages	-	-	2	1	ISE	---	---	100	50	
-	TOTAL	13	-	12	19						
	TOTAL CONTACT HOURS	25									

ISE - In Semester Evaluation, UT1 - Unit Test-1, UT2 -Unit Test-2, ESE - End Semester Exam.

Total Contact Hours/week : 25

Total Credits : 19

Technical Aptitude Courses : Mathematics for Mechanical Engineers, Manufacturing Processes and Machine Tools, Engineering Thermodynamics, Engineering Mechanics.





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To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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-III	SH2734
6.		Japanese Language-III	SH2714

Note:

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





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Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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	
ME216	Fluid Mechanics and Turbomachinery	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
ME2124	Mechanics of Solids	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
ME2144	Material Science and Metallurgy	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	---
-	Modern Indian Language	2	-	-	2	ISE	100	50	---	---	-
SH2174	Environmental Science	1	-	2	2	ISE	50	40	40	---	---
						ESE	50	40		---	---
ME2204	Fluid Mechanics and Turbomachinery Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---		50	50
ME2224	CAD Modelling Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---		50	50
ME2244	Material Science and Metallurgy Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---		50	50
ME2344	Workshop Practice-II	-	-	2	1	ISE	---	---		100	50
ME2364	Technical Aptitude-II	-	-	2	1	ESE	---	---		100	50
-	Professional Skills Development and Foreign Languages-II	-	-	2	1	ISE	---	---	--	100	50
-	TOTAL	15	-	14	22	-					
	TOTAL CONTACT HOURS	29									

ISE - In Semester Evaluation, UT1 - Unit Test I, UT2 - Unit Test II, ESE - End Semester Exam.

Total Contact Hours/week : 29

Total Credits : 22

Technical Aptitude Courses : Fluid Mechanics and Turbomachinery, Mechanics of Solids, Material Science and Metallurgy.

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





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To be implemented for 2023-27 Batch
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Rev: ME Course/RIT/02/2023-27.

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-IV	SH2644
6.		Japanese Language-IV	SH2624

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)

Sr. No.	Modern Indian Language: Subject Name	Course Code
1	मराठी भाषिक कौशल्यविकास	SH202
2	हिंदी कथा साहित्य एवं प्रयोजमूलक हिंदी	SH204





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Rev: ME Course/RIT/02/2023-27.

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
ME3114	Heat and Mass Transfer	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
ME313	Kinematics and Dynamics of Machines	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	2	-	-	2	ISE	50	40	40	---	---
						ESE	50			40	---
ME315	Design of Machine Elements	3	-	-	3	ISE	20	40	40	---	---
						UT1	15			---	---
						UT2	15			---	---
						ESE	50			40	---
ME3214	Heat and Mass Transfer Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---	---	50	50
ME3234	Kinematics and Dynamics of Machines Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---	---	50	50
ME3254	Software Training Lab-I	-	-	2	1	ISE	---	---	---	100	50
SH3035	Scholastic Aptitude-I	2*	-	-	Audit	ISE	100	50 (P/NP)	---	---	---
ME3835	Summer Internship	-	-	-	1	ISE	---	---	---	100	50
ME399	MOOCS**	-	-	-	1	ISE	---	---	---	100	50
-	TOTAL	19	-	6	24	-					
	TOTAL CONTACT HOURS	25									

ISE - In Semester Evaluation, UT1 - Unit Test I, UT2 - Unit Test II, ESE - End Semester Exam. P-Pass and NP-Not Pass.

Total Contact Hours/week : 25

Total Credits : 24

Note:

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

* **MOOC course certification marks will be carried out for the credits.





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Rev: ME Course/RIT/02/2023-27.

Program Elective-I

Sr. No	Course Code	Domain	Course
1.	ME3314	Design	Mechanics of Composite Material
2.	ME333		Engineering Optimization
3.	ME3354		Fracture Mechanics
4.	ME336		Python Programing
5.	ME3414	Thermal	Cogeneration and waste heat utilization
6.	ME343		Alternative sources of energy
7.	ME345		Hybrid and Electric Vehicles
8.	ME3514	Manufacturing	World Class Manufacturing
9.	ME3534		Non-Traditional Machining Process
10.	ME359		Operations Research
11.	ME363		Quality Management System
12.	ME3594		Production and Operation Management
13.	ME361		Sensors and Actuators in Robotic Technology

Open Elective - I

Sr. No	Course Code	Course Name	Offered By Department
1	OE3044	Renewable Energy Sources	Robotics & Automation
2	OE3064	Environmental Impact Assessment	Civil Engineering
3	OE3104	Network Administration	Computer Science and Engineering
4	OE3381	Disaster Management	Civil Engineering
5	OE341	Energy Audit and Management	Electrical Engineering
6	OE343	Data Science	Computer Science & Engineering (Artificial Intelligence and Machine Learning)
7	OE365	Distributed Systems	Computer Science and Information Technology
8	OE347	New Product Design & Development	Mechanical Engineering
9	OE349	Non-Conventional Energy Sources	Mechanical Engineering
10	OE351	Hydrogen & Fuel Cell Technology	Mechanical Engineering
11	OE353	Factory Automation	Mechatronics Engineering Dept.
12	OE355	Cyber Physical System	Mechatronics Engineering Dept.
13	OE357	Internet of things	Electronics & Telecommunication





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To be implemented for 2023-27 Batch

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			Engineering
14	OE359	Drone technology	Electronics & Telecommunication Engineering
15	OE361	Object Oriented Modeling and Design	Computer Science and Information Technology
16	OE363	Robotics Engineering & Applications	Robotics & Automation

Software Training Lab-I (ME3254)

Sr. No.	Software courses
1.	NX CAM
2.	NX CAD
3.	MATLAB
4.	Software Development using C++



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Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

Class: T. Y. B. Tech

Semester: VI

Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)		
							Max	Min. for passing	Max	Min. for passing	
ME3104	Finite Element Method	2	-	-	2	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
ME3124	Applied Thermal Engineering	3	-	-	3	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
ME378	Machine Design	3	-	-	3	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
ME316	Research Methodology	2	-	-	2	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
-	Program Elective-II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
-	Open Elective-II	3	-	-	3	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
-	Multidisciplinary Minor-V	3	-	-	3	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
ME380	Mechatronics and Automation	3	-	-	3	ISE	20	40	40	---	---
						UT1	15				
						UT2	15	40			
						ESE	50				
ME3644	Software Training Lab-II	-	-	2	1	ISE	--	--	--	50	50
						ESE	---	---	---	50	50
ME3664	Applied Thermal Engineering Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---	---	50	50
SH3065	Scholastic Aptitude-II	2*	-	-	Audit	ISE	100	50 (P/NP)	---	---	---
ME3764	Capstone project Phase I	-	-	2	1	ISE	---	---	---	100	50
-	TOTAL	22	-	4	25	-					
	TOTAL CONTACT HOURS	26									

ISE - In Semester Evaluation, UT1 - Unit Test I, UT2 - Unit Test II, ESE - End Semester Exam, P-Pass and NP-Not Pass.

Total Contact Hours/week : 26

Total Credits : 25

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





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Program Elective-II

Sr.No.	Course Code	Discipline	Course
1.	ME322	Design	Industrial Robotics
2.	ME3264		Machine Tool Design
3.	ME328		Smart Material and Systems
4.	ME3304		Engineering Acoustics
5.	ME3364	Thermal	Energy Conservation & Management
6.	ME3384		Gas Turbine & Jet Propulsion
7.	ME340		Computational Fluid Dynamics (CFD)
8.	ME3424		Alternative Fuels
9.	ME3484	Manufacturing	Computer Integrated Manufacturing
10.	ME3504		Total Productive Maintenance
11.	ME3524		Tool Engineering
12.	ME3544		Industrial Organization and Management
13.	ME368		Robot Dynamics and Applications
14.	ME382		Process Equipments and Engineering

Open Elective-II

Sr. No.	Course Code	Course Name	Offered By Department
1	OE3024	Reliability Engineering	Robotics & Automation
2	OE3084	Materials Management	Civil Engineering
3	OE3182	Industrial Drives	Electrical Engineering
4	OE3284	Supply Chain Management	Mechanical Engineering
5	OE3324	Entrepreneurship Development	Mechanical Engineering
6	OE3401	Cyber Security	Computer Science and Information Technology
7	OE342	Data Mining	CSE(AI&ML)
8	OE344	Supply Chain Analytics	Mechatronics Engineering Dept.
9	OE346	Mobile Robotics	Mechatronics Engineering Dept.
10	OE348	Information Technology Foundation Program	Computer Science and Engineering
11	OE350	Operations Research	Civil Engineering
12	OE352	Image Processing	Electronics & Telecommunication Engineering



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Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

13	OE354	Fuzzy logic and Neural Network	Electronics & Telecommunication Engineering
14	OE356	Project Management	Mechanical Engineering
15	OE358	Plumbing (Water and Sanitation)	Civil Engineering
16	OE362	Flexible Manufacturing System	Robotics & Automation
17	OE364	AI for Manufacturing	Computer Science and Information Technology
18	OE366	AI for Cybersecurity	Computer Science and Engineering
19	OE368	AI for Agriculture	CSE(AI&ML)
20	OE370	AI for Sustainability	Electronics & Telecommunication Engineering
21	OE3242	Marketing for Engineers	MBA

Software Training Lab-II (ME3644)

Sr. No.	Software courses
1.	ABAQUES
2.	HYPERMESH
3.	ANSYS
4.	Computational Fluid Dynamics (CFD)





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Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

Class: Final Year B. Tech

Semester: VII

Class: Final Year B.Tech											
Course Code	Course	Teaching Scheme				Evaluation Scheme					
		L	T	P	Credits	Scheme	Theory (Marks %)		Practical (Marks %)		
							Max.	Min. for passing	Max.	Min. for passing	for
ME4894	Mechanical System Design	3	-	-	3	ISE	20	40	40	---	---
						MSE	30			---	---
						ESE	50			---	---
						ISE	20			---	---
ME4034	Metrology and Control Engineering	3	-	-	3	MSE	30	40	40	---	---
						ESE	50			---	---
						ISE	20			---	---
						ESE	50			---	---
ME4054	Industrial Engineering	2	-	-	2	MSE	30	40	40	---	---
						ESE	50			---	---
						ISE	20			---	---
						ESE	50			---	---
-	Program Elective-III	3	-	-	3	MSE	30	40	40	---	---
						ESE	50			---	---
						ISE	20			---	---
						ESE	50			---	---
-	Program Elective-IV	3	-	-	3	MSE	30	40	40	---	---
						ESE	50			---	---
						ISE	20			---	---
						ESE	50			---	---
ME4074	Mechanical System Design Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---	---	50	50
ME4094	Industrial Engineering and Quality control Lab	-	-	2	1	ISE	---	---	---	50	50
						ESE	---	---	---	50	50
ME4114	Metrology and Measurement Lab	-	-	2	1	ISE	---	---	---	100	50
ME4134	Workshop Practice III (IR4)	-	-	2	1	ISE	---	---	---	100	50
-	Program Elective-IV Lab	-	-	2	1	ISE	--	---	---	50	50
						ESE	--	---	---	50	50
ME4874	Capstone Project Phase II	-	-	6	3	ISE	--	---	---	50	50
						ESE	--	---	---	50	50
-	TOTAL	14	-	16	22	-					
	TOTAL CONTACT HOURS	30									

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

Total Contact Hours/week : 30

Total Credits : 22



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Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.



Program Elective-III

Sr.No.	Course Code	Discipline	Course
1.	ME4154	Design	Condition Monitoring
2.	ME423		Computer Aided Design and Analysis
3.	ME4194		Autotronics & Vehicle Intelligence
4.	ME421		Engineering Failure Analysis
5.	ME4234	Thermal	Cryogenics
6.	ME425		Design of Heat Exchanger
7.	ME427		Battery Thermal Management system
8.	ME429	Manufacturing	Foundry Technology
9.	ME431		Enterprise Resource Planning (ERP) and Product Life Cycle Management (PLM)
10.	ME433		Sustainable Manufacturing
11.	ME435		Digital Manufacturing

Program Elective-IV

Sr.No.	Course Code	Discipline	Course
1.	ME4394	Design	Mechanical Vibration
2.	ME4414		Experimental Stress Analysis
3.	ME4434		Engineering Tribology
4.	ME495		Industry Textile and Applications: Noise & Vibration reduction
5.	ME447	Thermal	I C Engines
6.	ME4494		Refrigeration and Air conditioning
7.	ME4514		Automotive Engineering
8.	ME4574	Manufacturing	Mechatronics system Design
9.	ME4554		Industrial Hydraulics and Pneumatics
10.	ME459		Additive Manufacturing
11.	ME461		Mechatronics and IoT





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Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

Program Elective-IV Lab

Sr. No	Course Code	Discipline	Course
1.	ME4634	Design	Mechanical Vibration Lab.
2.	ME4654		Experimental Stress Analysis Lab.
3.	ME467		Engineering Tribology Lab.
4.	ME499		Industry Textile and Applications: Noise & Vibration reduction Lab
5.	ME4734	Thermal	I C Engines Lab
6.	ME4754		Refrigeration and Air conditioning Lab
7.	ME4774		Automotive Engineering Lab
8.	ME4814	Manufacturing	Mechatronics System Design Lab
9.	ME479		Industrial Hydraulics and Pneumatics Lab
10.	ME483		Additive Manufacturing Lab
11.	ME485		Mechatronics and IoT Lab



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Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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 %)		Practical (Marks %)		
							Max.	Min. for passing	Max.	Min. for passing	for
OE4382	Financial Management (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	4	-	-	16	---	---	---		---	---

ISE - In Semester Evaluation, ESE - End Semester Exam.

Total Contact Hours/week : --
Total Credits : 16

Note:

- 1] Weekly Contact hours are not mentioned as student is expected to be in industry regularly for 20 weeks. However, student needs to report to Institute mentors as and when required.
- 2] For online course, lecture videos of each unit will be made available through college platform to the students. For each unit there will be separate assignment. Students need to submit all assignments within specified time.

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





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To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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	4	-	-	16	---	---	---		---	---

ISE - In Semester Evaluation, UT1 - Unit Test I, UT2 - 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 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			Credits	Evaluation Scheme					
		L	T	P		Scheme	Theory (Marks %)		Practical (Marks %)		
							Max	Min. for passing	Max	Min. for passing	
ED4104	Project Management (Online Course)	2	-	-	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	50
-	TOTAL	4	-	-	16	-	-	-	-	-	-

ISE - In Semester Evaluation, UT1 - Unit Test I, UT2 - 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 an Entrepreneurial Internship need to undergo a one month internship at an outside reputed organization or a firm.

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

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



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

Multidisciplinary Minor

Note:

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

• Multidisciplinary Minor Baskets					
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	





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

	4	EEMD303	Electrical Technology	V	
	5	EEMD302	Smart Grid	VI	
Electronics System Design	1	ECMD201	Electronics Devices and Applications	III	Electronics & Telecommunication Engineering
	2	ECMD202	Electronics Communication Systems	IV	
	3	ECMD301	Advanced Communication Systems	V	
	4	ECMD303	Electronic Product Design	V	
	5	ECMD302	Industrial Electronics	VI	
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	IV	



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

			Power		
	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 Artificial Intelligence	VI	
Robotics & Automation	1	RAMD201	Fundamentals of Robotics & Automation	III	Robotics & Automation
	2	RAMD202	Sensors and Actuators	IV	
	3	RAMD301	Kinematic & Dynamics for Robots	V	
	4	RAMD303	Robot Programming	V	
	5	RAMD302	Industrial Automation and Control	VI	





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

B.Tech. in Mechanical Engineering with Double Minor (Multidisciplinary and Specialization Minor)





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

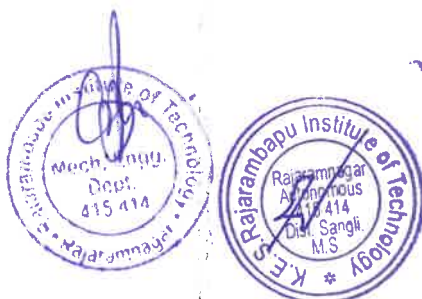
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B.Tech. in Mechanical Engineering with Double Minor degree

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	MEDM3XXX
2	IV	DM – II	MEDM4XXX
3	V	DM – III	MEDM5XXX
4	VI	DM – IV	MEDM6XXX
5	VII	DM – V	MEDM7XXX
6	VIII	DM – VI	MEDM8XXX

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.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

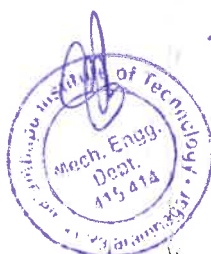
B.Tech. in Mechanical Engineering with Honor and Multidisciplinary

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	MEH3XXX
2	IV	Honor - II	MEH4XXX
3	V	Honor - III	MEH5XXX
4	VI	Honor - IV	MEH6XXX
5	VII	Honor - V	MEH7XXX
6	VIII	Honor - VI	MEH8XXX

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.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

B.Tech. in Mechanical Engineering-Honors with Research and Multidisciplinary Minor





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
 Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

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 Mechanical Engineering-Honors with Research and Multidisciplinary Minor degree Student need to earn total 206 Credits which consist 170 credits of regular Multidisciplinary Minor courses, 18 Credits of Honor courses and 18 credits of Research courses

Class: Final Year B. Tech

Semester: VII

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

ISE - In Semester Evaluation, 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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Rev: ME Course/RIT/02/2023-27.

Class: Final Year B. Tech

Semester: VIII

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

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech Mech	Semester: V
Course Code: ME3114	Course Name: Heat and Mass Transfer

L	T	P	Credits
3	--	--	3

Course Description:

The Heat Transfer course explores fundamental principles and mechanisms governing heat movement in diverse materials and systems. It encompasses modes like conduction, convection, and radiation, incorporating mathematical modeling for practical applications in engineering and physics. Students gain skills in analyzing and designing systems for effective heat transfer, with an emphasis on real-world applications in thermal engineering, HVAC systems, materials science, and an introduction to concepts in mass transfer.

Course Learning Outcomes:

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

1. Explain modes of heat transfer and solve steady and unsteady state heat conduction problems.
2. Apply the principles of radiation heat transfer to engineering problems
3. Develop and use various correlations to solve convection problems.
4. Analyse and design an indirect tube type heat exchanger.

Prerequisite:

Students should know concept in thermodynamics, fluid mechanics, and engineering mathematics.

Course Content

Unit No	Description	Hrs.
1. Introduction	Modes of heat transfer, Basic laws of heat transfer, Introduction to mass transfer, Fick's law of diffusion, Thermal conductivity and its variation with temperature for various engineering materials, Introduction to mass transfer. Steady State Heat Conduction Derivation of generalized heat conduction equation in Cartesian co-ordinate, Heat conduction through plane and composite wall, cylinder, sphere; critical radius of insulation for cylinder and sphere insulation for cylinder and sphere	08
2. Extended Surfaces	Types and applications of fins, General heat conduction equation for fins, Different boundary condition of fins, Heat transfer through rectangular and circular fins, Fin effectiveness and efficiency.	04
3. Unsteady State Heat Conduction	Lumped heat capacity analysis, Biot and Fourier number and their significance, Heisler and Grober charts. Heat conduction with Heat generation -Heat conduction with heat generation for slab	06
4. Radiation	Concept of black body and gray body, Kirchhoff's law, Stefan Boltzman law. Lambert cosine rule, intensity of radiation, Energy exchange by radiation	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

	between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces. Geometric shape factor, Electrical network analogy surface and space resistance.	
5. Convection	Concept of Hydrodynamic and thermal boundary layer, Local and average convective heat transfer coefficient, Dimensional analysis for natural and forced convection, Significance of dimensionless numbers, Numerical correlations to solve free and forced convection problems, Introduction to boiling and condensation phenomenon.	06
6. Heat Exchangers	Classification and Types of Heat exchangers, Fouling factor, Overall heat transfer coefficient, Analysis by logarithmic mean temperature difference method and number of transfer unit method for parallel and counter flow, Design consideration for Heat exchangers. Design of heat exchangers,	06

References:

Text Books:

- R.K. Rajput, Heat and Mass Transfer, S, Chand and Company Ltd., New Delhi.
- Dr. D. S. Kumar, Heat and Mass Transfer, S.K. Kataria and Sons, Delhi.
- P.K. Nag, Heat Transfer, Tata McGraw Hill publishing Company Ltd., New Delhi

Reference Books:

- R.C. Sachdev Heat and Mass Transfer, Tata MacGraw Hill Publisher.
- J.P.Holman Heat Trasfer, Tata MacGraw Hill Publisher.
- M.Necati Ozisik A Basic Approach to Heat Transfer, Tata MacGraw Hill International Edition.
- Ynus A Cengel, Heat Transfer a Practical Approach, Tata MacGraw Hill.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech Mech	Semester-V
Course Code: ME313	Course Name: Kinematics and Dynamics of Machines

L	T	P	Credits
3	--	--	3

Course Description:

The course is intended to build up necessary background for understanding the kinematics, mechanisms and dynamic behavior of machines, balancing procedure for balancing of different types of engines, vibration phenomenon, causes, effect and remedies of vibrations. As a Mechanical Engineering student, this course has very much importance to analysis and design of many industrial types of machinery for getting smooth, precise operation and comfort with higher accuracy.

Course Learning Outcomes:

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

1. Select suitable mechanism to get desired motion.
2. Analyze the mechanism for velocity and acceleration.
3. Demonstrate the gyroscopic effect and functioning of governors.
4. Evaluate dynamic forces & its effects on mechanical system.
5. Analyze vibration of single degrees of freedom system.

Prerequisite:

Applied Mechanics, Engineering Mathematics viz. Differential Equations and its Solution

Course Content		
Unit No	Description	Hrs
1.	Mechanisms and Machines Introduction, mechanisms and machines, terminology, planar mechanism - Kinematic diagram and inversion, Mobility, Coincident joints, Grubbler and Grashoff's law, Four bar, single and double slider mechanisms and their inversions. Cams: Types of cams – Types of followers – Definitions – Motions of the followers – Layout of cam profiles. Gear: terminology, fundamental of gearing, involute profile, interference and undercutting, minimum number of teeth, contact ratio - Gear trains: simple, compound.	06
2.	Velocity and Accelerations in Mechanisms Velocity and acceleration in planar mechanisms - Relative velocity method, Coriolis component of acceleration, Kennedy's Theorem, Instantaneous Centre method	06
3.	Governors and Gyroscope Governors: Centrifugal Governors- types and its characteristics - Working principle of electronic governor. Gyroscope – Gyroscopic Effects on the Movement of airplanes and Ships – Gyroscope Stabilization.	06
4.	Balancing of Rotary and Reciprocating Masses Balancing of several masses rotating in same plane, Balancing of several masses rotating in different planes, Balancing of single cylinder, Multi-cylinder inline engine, Balancing of radial engines, Field balancing,	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	Balancing machines.	
5.	Free Vibrations of Single Degree of Freedom (SDOF) System Fundamentals of Vibrations: Definitions, Terminology and Classification of vibration, Undamped Free Vibrations, Damped Free Vibrations: Different types of damping, free vibration with viscous damping – overdamped, critically damped and underdamped systems, logarithmic decrement	06
6.	Forced Vibrations of Single Degree of Freedom System Forced vibrations with constant harmonic excitations, Frequency response plot, forced vibrations with rotating and reciprocating unbalance, forced vibrations due to base excitations, force transmissibility, Motion transmissibility, Vibration Measuring Instruments.	06

References:

Text Books:

- Ratan S.S, Theory of Machines, Tata McGraw Hill New Delhi.
- P.L.Ballany, Theory of Machines & Mechanism, Khanna Publication, New Delhi.
- V.P. Singh, Theory of Machines, Dhanpat Rai and Sons.
- S Graham Kelly, Fundamentals of Mechanical Vibrations, Tata McGraw-Hill.
- G.K. Groover, Mechanical Vibrations, Nemchand & Brothers .

Reference Books:

- Uicker, J.J., Pennock G.R and Shigley, J.E., Theory of Machines and Mechanisms, Oxford University Press.
- Thomas Bevan, Theory of Machines, CBS Publishers and Distributors.
- Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill.
- S. S. Rao, Mechanical Vibrations, Pearson Publication.
- Pujara K, Vibration & noise for Engineering, Dhanpat Rai and Company.
- Thomas Bevan, Theory of Machines, CBS Publishers, New Delhi.
- Shigley, Theory of Machines and Mechanism, McGraw Hill, New York.
- J.S. Rao and R.V. Dukipatti, Theory of Machines and Mechanism, New Age Int. Publications Ltd. New Delhi.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T.Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3314	Course Name: Mechanics of Composite Material	2	--	--	2

Course Description:

Composite materials are replacing almost every conventional material in all sectors due to inherent advantage of high strength to weight ratio, excellent corrosion resistance, high fatigue strength, faster assembly, etc. Thus, several industrial sectors like aerospace, automotive, defense are continuously striving hard to characterize the composite material and improve the efficiency. This course is aimed at providing exposure to general applications of composite, fabrication process, micro-mechanics of lamina and laminate, failure theories. At the end of this course, students are expected to apply the basic concepts of the mechanics of composite materials and suggest suitable composite material as a replacement for conventional material.

Course Learning Outcomes:

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

1. Choose suitable composite materials based on field applications
2. Explain different fabrication processes and perform cost comparison.
3. Compute composite properties for given fraction of fibers and matrix.
4. Design lamina to bring tailor made properties in composite material.
5. Predict failure of composite laminates by selecting appropriate failure criteria.
6. Design laminate for given loading conditions.

Prerequisite:

Strength of material, Design of machine components.

Course Content		
Unit No	Description	Hrs.
1.	Basics of Composite Material Introduction to Composite Material, Fibers and Matrix, Fibers, Matrix Materials, Applications of Composite Materials, Examples of the Use of Composite Materials, Examples on Replacing Conventional Solutions with Composites, Principal Physical Properties. Applications of composite material.	04
2.	Fabrication Processes Molding Processes: Contact Molding, Compression Molding, Molding with Vacuum, Resin Injection Molding, Molding by Injection of Premixed, Molding by Foam Injection, Molding of Components of Revolution.	03
3.	Micro-Mechanics of composites Concept of volume fraction and mass fraction, Computation of properties of composite material such as density, Youngs modulus, Poisons ratio, shear modulus, tensile strength, coefficient of thermal expansion, coefficient of moisture expansion.	03
4.	Micromechanics of Lamina Concept of stress, strain and its relationship. Stress-strain relation of different	05



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

	types of material like anisotropic material, monoclinic material, orthotropic and isotropic material etc. Stress-strain relation of 2D unidirectional lamina. Concept of plane stress and strain. Computation of compliance and stiffness matrix.	
5.	Micromechanics of Laminate Introduction to laminate, laminate codes, stress-strain relation for laminate, one-Dimensional Isotropic Beam Stress-Strain and Strain-Displacement equations, Force and Moment Resultants related to midplane Strains and Curvatures, In-Plane and Flexural Modulus of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates.	05
6.	Failure Analysis and Design of Laminates Special Cases of Laminates, symmetry of laminate, cross ply laminate, angle ply laminate, anisometric laminate, balanced laminate, balanced laminate, failure criteria of laminate, design of laminated composite, other properties of laminate.	04

References:

Text Books:

- Autar K. Kaw, Mechanics of Composite Materials, CRC Press.
- Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill.
- George Z. Voyiadjis and Peter I. Kattan, Mechanics of Composite Materials with MATLAB, Springer.

Reference Books:

- Mallick, P.K, Fiber Reinforced Composites: Materials, Manufacturing and Design, Marcel Dekker.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T.Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME333	Course Name: Engineering Optimization	2	--	--	2

Course Description:

This course is an introduction to optimization theory and its applications to problems arising in engineering. In the most general terms, optimization theory is a body of mathematical results and numerical methods for finding and identifying the best candidate from a collection of alternatives without having to explicitly enumerate and evaluate all possible alternatives. The process of optimization lies at the root of engineering, since the classical function of the engineer is to design new, better, more efficient, and less expensive systems as well as to devise plans and procedures for the improved operation of existing systems.

The power of optimization methods to determine the best case without actually testing all possible cases comes through the use of a modest level of mathematics and at the cost of performing iterative numerical calculations using clearly defined logical procedures or algorithms implemented on computing machines. Here the emphasis is on the ideas and logic underlying the methods, on the factors involved in selecting the appropriate techniques, and on the considerations important to successful engineering application.

Course Outcomes:

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

1. Apply necessary and sufficient conditions for a given optimization problem for optimality.
2. Select appropriate solution methods and strategies for solving an optimization problem
3. Interpret and analyze the solution obtained by specific method
4. Solve engineering Design and Manufacturing related optimization problems

Prerequisite:

Basic vector-matrix manipulations, linear algebra and calculus.

Course Content

Unit No.	Description	Hrs
1.	Applications and Classification of Optimization Problems Historical Developments and Review. Engineering applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems	03
2.	Linear Programming Simplex method, Revised simplex method, Two phase method, Duality, Dual simplex method, Integer linear programming, 0-1 integer linear programming, solution by branch and bound method.	05
3.	Classical Optimization Techniques Introduction, Review of single and multi-variable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, Examples.	04



4.	Constrained Optimization Techniques Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems	04
5.	Unconstrained Optimization Techniques Introduction, Direct search method – Random, Univariate and Pattern search methods, Rosenbrock's method of rotating coordinates, Descent methods - Steepest Decent methods- Quasi-Newton's and Variable metric method, Examples.	04
6.	Geometric Programming Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, Constrained minimization problems,	04

References:

Text Books:

- A. Ravindran, K. M. Ragasdel, G. V. Reklaitis, Engineering Optimization-Methods and Applications, Wiley India
- S. S. Rao, Engineering Optimization: Theory and Application, Wiley India

Reference Books:

- David G. Luenberger, Yinyu Ye, Linear and Non Linear Programming, Springer





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V
Course Code: ME3354	Course Name: Fracture Mechanics

L	T	P	Credits
2	--	--	2

Course Description:

Realistic design and estimating life of a component with the modern technology is the demand of present generation. The knowledge of presence of crack, crack initiation, crack propagation and its influencing factors like loading, material behavior and environmental conditions are essential to predict fail-safe design. The advantages associated with design of components based on fracture mechanics point of view as opposed to the classical strength of material approach is the essence of this course. The topics covered are Linear elastic fracture mechanics, plastic mechanics, Dynamics and time dependent fracture mechanics in metals and non-metals, Fatigue crack propagation and computational mechanics.

Course Learning Outcomes:

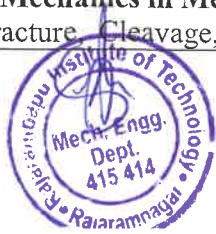
After successful completion of the course, students will be able to,

1. Apply the basic principles of Linear elastic fracture mechanics.
2. Design the engineering components using elastic-plastic fracture mechanics principles.
3. Explain the process of crack growth and arrest in the presence of creep.
4. Compare the fracture behavior in metals and non-metals.
5. Analyze the crack growth under fatigue loading.
6. Choose the suitable computational fracture mechanics approach to solve the real mechanical engineering problem.

Prerequisite:

Strength of material, Design of Machine elements, Metallurgy.

Course Content		
Unit No	Description	Hrs
1.	Introduction History and overview of fracture mechanics, Linear elastic fracture mechanics (LEFM), Griffith energy balance, Instability and R-Curves, Stress analysis of a crack, crack tip plasticity, Mixed mode fracture, Interaction of multiple crack.	04
2.	Elastic Plastic Fracture Mechanics Crack tip opening displacement (CTOD), Relationship between J-integral and CTOD, Crack growth resistance curves, J-controlled fracture, Crack tip constraints on large scale yielding, Scale modeling for cleavage fracture, Limitation of two parameter fracture mechanics.	04
3.	Dynamic and Time Dependent Fracture Dynamic fracture and crack arrest, Creep crack growth, Visco-elastic fracture mechanics, Transition from linear to non-linear behavior.	04
4.	Fracture Mechanics in Metals and Non-metals Ductile fracture, Cleavage, Ductile-brittle transition, Intergranular fracture,	04





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	Yielding and fracture in polymer, Fiber reinforced plastic, Ceramic and ceramic composites, Fracture toughness testing metals and non-metals.	
5.	Fatigue Crack Growth Propagation Similitude in fatigue, Fatigue threshold, Variable amplitude, Loading and retardation, Growth of short crack, Micro-mechanism of fatigue.	04
6.	Computational Fracture Mechanics Finite element method, Boundary element method, Energy domain integral, Mesh design, Convergence study.	04

References:

Text Books:

- Prashant Kumar, Fracture Mechanics, McGraw Hill.
- K.R.Y. Simha, Fracture Mechanics for Modern Engineering, University Press.
- T.L.Anderson, Fracture Mechanics, Taylor and Francis.

Reference Books:

- Parton V.Z., Elastic Plastic Fracture Mechanics, Taylor and Francis.
- Hertzberg R. W., Deformation and Fracture Mechanics of Engineering materials, Willey.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME336	Course Name: Python Programming	2	--	--	2

Course Description:

This course aims to introduce third-year mechanical engineering students to the fundamentals of Python programming. Students will develop practical programming skills applicable to engineering problem-solving, data analysis, and automation. Emphasis will be placed on hands-on coding exercises and real-world applications in the field of mechanical engineering.

Course Learning Outcomes:

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

1. Understand Python code for basic programming tasks.
2. Acquire skills in handling and visualizing engineering data using Python.
3. Write object-oriented Python programs.
4. Apply numerical computing techniques to solve mechanical engineering problems.
5. Develop graphical user interfaces for engineering applications.
6. Use Python for automating tasks and extracting information from websites for engineering applications.

Prerequisite:

Students should Understand Mathematics, Engineering Problem-Solving Skills, Computer Literacy

Course Content		
Unit No	Description	Hrs.
1.	Python Basics Introduction to Python syntax and data types, Basic input/output and variables, Overview of control structures: loops and conditional statements	04
2.	Data Handling with NumPy Working with NumPy arrays, Basic data manipulation and analysis, Introduction to plotting with Matplotlib	04
3.	Basic Object-Oriented Programming Understanding classes and objects, Basics of encapsulation and inheritance	04
4.	Introduction to GUI Programming Basics of GUI design with Tkinter, Simple event-driven programming, Developing basic engineering applications with a graphical interface	04
5.	Web Scraping Basics Basics of web scraping using BeautifulSoup/Pytesseract, Extracting information from websites	04
6.	Automation with Python Basics of automating tasks with Python scripts, Application of automation in engineering workflows	04





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books:

- Kenneth A. Lambert, Michael R. Gann, and Michael J. Michael "Programming in Python", Cengage Learning India.
- Sheetal Taneja, Naveen Kumar "Python Programming: A Modular Approach", Oxford University Press.
- Martin C. Brown, "Python: The Complete Reference" by Publisher: McGraw Hill Education.
- Charles Severance "Python for Everybody: Exploring Data in Python 3" by, Pearson
- John Zelle "Python Programming: An Introduction to Computer Science" by, Franklin, Beedle & Associates Inc.

Reference Books:

- Brett Slatkin "Effective Python:90 Specific Ways to Write Better Python" by, Addison-Wesley
- David Beazley and Brian K. Jones, "Python Cookbook" by O'Reilly Media
- Richard Lawson "Web Scraping with Python: A Comprehensive Guide" by, Apress.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3414	Course Name: Cogeneration and Waste Heat Utilization	2	--	--	2

Course Description:

The Cogeneration and Waste Heat Recovery course delves into the principles and applications of simultaneous power and heat generation (cogeneration) and the effective utilization of waste heat. Students explore technologies, system designs, and optimization strategies aimed at improving energy efficiency across diverse industries. The curriculum covers the integration of combined heat and power (CHP) systems, various waste heat recovery methods, and their economic and environmental implications. The course emphasizes sustainable practices, highlighting the importance of waste heat as a valuable resource in industrial processes. Additionally, it addresses environmental issues, the current energy scenario, detailed energy audits, financial management, and related topics, making it a comprehensive exploration of energy management and environmental sustainability.

Course Learning Outcomes:

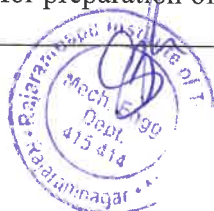
After successful completion of the course, students will be able to,

1. Illustrate concepts related to energy audits.
2. Summarize the energy scenario and emphasize the importance of energy conservation.
3. Explain the principles of Co-generation and Trigeneration.
4. Demonstrate various techniques for waste heat recovery.
5. Explain the elements incorporated in thermal utilities for efficient operation.
6. Describe various measures for energy conservation and analyze the financial implications for different thermal utilities.

Prerequisite:

Students should know concept in thermodynamics, fluid mechanics, Heat transfer.

Course Content		
Unit No	Description	Hrs.
1.	Energy Scenario Primary and Secondary Energy, Conventional and nonconventional energy, worlds and Indian energy scenario Energy Security, Energy Conservation and its importance, Energy conservation Act., Thermal Energy basics, Need of energy Audit and management, Global warming	04
2.	Energy Audit Energy Audit its definition & methodology, Energy Audit Instruments, Benchmarking for energy performance, Energy Action Planning, Duties and responsibilities of Energy Manager; Energy financial management, Project Management, Energy monitoring and targeting, pinch technology. Detailed energy audit Methodology, Standard guide for conducting energy audit, plant visit for preparation of energy audit phase I and Phase II considering a case study	04





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

3.	Cogeneration & Trigeneneration Definition, Need, Principle and Advantages, Classification of cogeneration systems, Factors influencing the choice of type of cogeneration power plant, Advantages and Disadvantage of cogeneration plant, Applications of cogeneration. Difference between trigeneration and cogeneration, Need for trigeneration plant, Efficiency, Advantages and disadvantages of Trigeneration Plant, application of Trigeneration.	04
4.	Waste Heat Recovery (WHR) Definition, Classification of WHR systems, Benefits of WHR, Classification of waste heat, Heat Recovery methods like recuperator, regenerator, Heat pipe exchanger, Thermal wheel, Economizer,	04
5.	Thermal Utilities: Operation and Energy Conservation Boilers, Thermic Fluid Heaters, Furnaces, Refrigeration Systems, Thermal Storage, Fans and Blowers, Electrical system, lighting, motors	04
6.	Waste heat management Investment – need, appraisal and criteria, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept	04

References:

Text Books:

- Smith, CB Energy Management Principles, Pergamon Press, New York.
- Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington.
- Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi.
- Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington
- Diamant, RME, Total Energy, Pergamon, Oxford.

Reference Books:

- Handbook on Energy Efficiency, TERI, New Delhi.
- Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com).
- Handbook of Energy Engineering Albert Treemann & Paul Mehta The Fiarmonth Press Inc
- G. L. Witte, Phillips S.Schmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
- Carig,B. Saith, Energy Management Principles, Applications, Benefit and Saving, Pern Press, New York.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T.Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME343	Course Name: Alternative sources of energy	2	--	--	2

Course Description:

Essentials of Alternative Energy. Theory and Applications of Solar thermal, Photovoltaics, Biomass biogas and biofuels, Fuel cells, Wind, Geothermal Energy, other Energy and Electric Vehicles.

Course Learning Outcomes:

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

1. Explain the basic renewable energy sources like solar, wind, biomass etc.
2. Explain various advantages and disadvantages of renewable energy sources.
3. Illustrate with different standalone off grid energy sources.
4. Explain different technology associate with solar, wind, biomass and other renewable energy sources

Prerequisite:

Thermodynamics, Heat Transfer, Fluid Mechanics.

Course Content

Unit No	Description	Hrs.
1.	Introduction Global and national energy scenarios, concept of energy services, patterns of energy supply, energy resource availability, cultural, economic and national security aspects of energy consumption, forms and characteristics of renewable energy sources, energy classification, source and utilization, thermodynamic power cycles and binary cycles.	04
2.	Solar Energy Solar radiation, flat plate collectors, solar concentration, thermal applications of solar energy, photovoltaic technology and applications, energy storage	04
3.	Biomass Energy Energy from biomass, thermo chemical, biochemical conversion to fuels, biogas and its applications, bio fuel and analysis	04
4.	Wind Energy Wind characteristics, resource assessment, horizontal and vertical axis wind turbines, electricity generation and water pumping, Micro/Mini hydropower system, water pumping and conversion to electricity, hydraulic pump.	04
5.	Alternate Sources Ocean thermal energy conversion, Geothermal, Tidal, Wave energy, MHD, Fuel cells, Nuclear power plants, hydrogen and fuel cells, Electric vehicles, environmental issues of energy services. Towards Carbon Neutrality	04





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

6.	Standalone generating units Synchronous generator and induction generator, operation and characteristics, voltage regulation, lateral aspects of renewable energy technologies and systems. Off design performance	04
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References:

Text Books:

- Alternative Energy Sources by Efstathios E. Stathis Michaelides at Springer-Verlag Berlin Heidelberg

Reference Books:

- Wind Power Plants Fundamentals, Design, Construction and Operation by Robert Gasch and Jochen Twele at Springer-Verlag Berlin Heidelberg.
- Bioenergy Biomass to Biofuels by A Dahiya at Academic Press
- Fuel Cells From Fundamentals to Applications by S Srinivasan at Springer US
- Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors by Vladimir S. Bagotsky, Alexander M. Skundin, Yuriy M. Volfkovich at Wiley.





K.E. Society's
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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Program Elective-I

Class: T.Y. B. Tech Mech	Semester: V
Course Code: ME345	Course Name: Hybrid and Electric Vehicles

L	T	P	Credits
2	--	--	2

Course Description:

The course introduces the fundamental concepts, principles, analysis, and design of hybrid and electrical vehicles. The course exposes the students to the electrical vehicle and hybrid electrical vehicle technologies and prepare them to avail developing opportunities in the area of hybrid electrical vehicles technology in automotive industry.

Course Learning Outcomes:

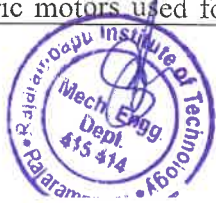
After successful completion of the course, students will be able to,

1. Identify the need for hybrid vehicles in today's context.
2. Explain the working of Electric Vehicles and recent trends.
3. Describe different configurations of electric and hybrid electric drive trains
4. Explain the design methodology and control strategies of hybrid drive trains.
5. Discuss different energy sources and drives required for hybrid vehicles.
6. Explain the fuel cell technology for hybrid vehicle applications.

Prerequisite:

The students should know the fundamentals of Basic Mechanical engineering, I. C. engine. and Energy Engineering

Course Content		
Unit No	Description	Hrs.
1.	Overview of Electric Vehicles Environment impact, Market scenario, Well-to-wheel analysis, Carbon credits, Conventional drive train, I C engine characteristics, Performance curves of typical manual transmission, Ideal power curve, GOI policy initiatives	04
2.	Electric vehicles - technology and design Configurations of EVs, Electric motor characteristics, Design process and issues, Modelling and performance estimation, Energy consumption, Regenerative brakes	04
3.	Hybrid electric vehicle technology Concept, Modes and operation patterns, Architectures of hybrid drive trains, Series hybrid drive train, Parallel hybrid drive train with torque coupling and speed coupling	04
4.	Series and Parallel hybrid drive trains Operation patterns, Design objectives, control strategies, Sizing of components, Parametric design	04
5.	Energy sources and drives for Electric Vehicles Electrochemical batteries, Charging of batteries, Charging infrastructure, Battery Management System (BMS), Supercapacitors, Ultra-high-speed flywheels, Electric motors used for EVs and HEVs like de motors, Induction	04





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	motors, Synchronous motors, SRM etc.	
6.	Fuel Cell Electric Vehicle drive train Fuel cell technology, Proton exchange membrane (PEM), and direct methanol fuel cell, Drive train design for FCVs.	04

References:

Text Books:

- Iqbal Hussain, Electric & Hybrid Vehicles: Design Fundamentals, CRC Press

Reference Books:

- Ehsani, Gao and Emadi, Modern Electric, Hybrid Electric and Fuel cell vehicles, CRC Press.
- James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons
- Robin Hardy, Iqbal Husain, Electric and Hybrid Vehicles, CRC Press
- Mike Westbrook, M H Westbrook, The Electric Car: Development & Future of Battery, Hybrid & Fuel-Cell Cars





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure, and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T.Y. B. Tech Mech	Semester: V
Course Code: ME3514	Course Name: World Class Manufacturing

L	T	P	Credits
2	--	--	2

Course Description:

With the initiation of industrial evolution, manufacturing has emerged globally. In competitive business environment companies must improve their manufacturing practice which is lean, efficient, lucrative and flexible. World class manufacturing is a group of concepts, which develops standards for production and manufacturing for another organization to follow. Japanese manufacturing is attributed for revolving the notion of world-class manufacturing.

Course Outcomes:

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

1. Explain characteristics of world class organization.
2. Plot control charts and comment on the process.
3. Elaborate the concept of TQM.
4. Demonstrate the 8 pillars of Total productive maintenance (TPM).
5. Demonstrate the 13 pillars of Toyota production system (TPS).
6. Explain the six sigma methodologies.

Prerequisite:

In order to complete this course successfully student should possess:

- Knowledge of Manufacturing Processes.
- Knowledge of Manufacturing Systems
- Knowledge of Quality Control.

Course Content

Unit No	Description	Hrs
1.	Historical Perspective Definition of World Class, Meaning of World Class Organization. Characteristics of World Class Organization. Competing in the world market. World Class Manufacturing (WCM).. Principles of WCM. WCM performance measurements. WCM Benefits.	04
2.	WCM Tools World class performance benchmarks. Value added manufacturing. Lean manufacturing. Four goals of lean Manufacturing. Seven types of wastes. Value Stream Mapping (VSM). Characteristics of VSM, VSM Symbols, Four stages of VSM, Lean thinking,	04
3.	Total Quality Management (TQM) TQM definition, Historical evolution of TQM, Understanding quality, Framework of TQM, Statistical process Control (SPC), Variation in manufacturing, Control charts, variable vs attribute data,	04
4.	Total Productive Maintenance (TPM) Maintenance types, Total Productive maintenance Benefits of TPM, Overall	04





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	Equipment Effectiveness (OEE), Total effective equipment performance (TEEP), 8 pillars of TPM, , Benefits of TPM,	
5.	Toyota Production System (TPS) Toyota production system, KANBAN, 13 pillars of TPS, Just-in-Time, Jidoka, Kanban, Muda, Muri, Mura, Genba, Genchi Genbutsu, Heijunka Andon, Kaizen, Konnyaku Stone, Poka-Yoke, Hansei, Nemawashi.	04
6.	Six Sigma History of six sigma. Definition of six sigma. Characteristics of six sigma. Six sigma objectives, Lean six sigma, Six sigma methodologies, Six sigma tools and techniques, 1.5 sigma shift, Role and responsibility of management,	04

References:

Text Books:

- Sahay B. S., Saxena K. B. C. and Ashish Kumar, World Class manufacturing – Strategic Perspective, McMillan Publications, New Delhi.
- Schonberg R. J., World Class manufacturing – The Lesson of Simplicity, free Press.

Reference Books:

- Marcus A. A., Management Strategy: achieving sustained competitive advantage, New York: McGraw Hill/Irwin
- Voss C. A., Manufacturing Strategy: Process and Content, Chapman and Hall, London
- Pascal D., Lean production simplified, Productivity Press.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3534	Course Name: Non-Traditional Machining Processes	2	--	--	2

Course Description:

Present day manufacturing scenario is characterized by Growing demand for high performance parts made of very hard, high strength materials, need for economic manufacture of high quality precision parts in small batches and large variety Increasing parts complexity, and growing trend towards miniaturization of parts with high degree of reliability. In addition, it is difficult to specify a tool material for economic machining of materials such as, super alloys, ceramics, tungsten carbides, composites etc. The traditional machining methods in case of such materials are unable to meet the requirements of the surface finish, production rate, close tolerances etc.

Advanced machining techniques are based on the direct application of energy for metal removal by mechanical or thermal erosion or electro-chemical dissolution. These processes do not rely on metal removal due to stressing of the part by the cutting tool leading to plastic deformation and chip formation. These machining processes become still more important when one considers the precision machining and ultra-precision machining. Some of the non-conventional techniques like ECM, USM, EDM, AJM, HERF, HVF, Advanced welding & surface treatments, can achieve high accuracy.

Course Learning Outcomes:

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

1. Compare the various nontraditional machining processes
2. Discuss the operational principles, advantages applications, limitations of the various non-traditional machining processes
3. Explain the material removal mechanism, effect of parameters/ factors associated with the processes on the machining performance.
4. Select a process /a combination of processes for a specific application/ need/situation depending upon the availability of sources.

Prerequisite:

Knowledge of traditional machining processes.

Course Content		
Unit No	Description	Hrs
1.	Overview of Non-Traditional Machining Processes Need for non-traditional machining processes. Processes selection & classification on – comparative study of different processes. Mechanical Energy Based Process Ultrasonic Machining (USM): Equipment and material removal process, Effect of process parameters on performance of the process. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. Abrasive Jet Machining (AJM): Equipment, and process of material removal,	04



	process variables: carrier gas, type of abrasive, work material, standoff distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM,	
2.	Electro Thermal Metal Removal Process Electric discharge machining: Principle of operation –mechanism of metal removal, basic EDM circuitry, material removal rate in EDM, effect of various parameters on performance of the process, Advantages, Limitations and Applications.	04
3.	Electro Chemical and Chemical Processes Electro chemical machining (ECM) ECM process-principle of ECM, Chemistry of the ECM, parameters of the processes, determination of the metal removal rate, -Advantages, disadvantages & applications. Electro Chemical Grinding, Chemical Machining: Introduction-fundamental principle types of chemical machining ,Mask ants, Etchants- Advantages, disadvantages & applications.	04
4.	Thermal Metal Removing Processes Plasma Arc Machining (PAM) and Laser Beam Machining (LBM) Introduction, Generation of Plasma and equipment, Mechanism of metals removal, parameters-process characteristics - type of torches, applications. Electron Beam Machining (EBM): Introduction-Equipment for production of Electron beam -Theory of electron beam machining Thermal & Non thermal type's characteristics, applications.	04
5.	High Energy Beam Machining Electron Beam Machining (EBM) & Ion Beam machining: (IBM) Introduction-principle of EBM Equipment and Machining procedure-Process characteristics-advantages and limitations applications Ion Beam Machining Process: Introduction Working principle of operation, parameters, advantages and applications.	04
6.	High Velocity forming process& Hybrid Non-Traditional machining processes Introduction, development of specific process selection comparison of conventional and high velocity forming methods - Types of high velocity forming methods- explosion forming process-electro hydraulics forming, magnetic pulse forms.	04



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books:

- Jagadeesha T, Non- Traditional Machining Processes, IK International Publishing House.
- V.K.jain, Advanced Machining Processes, Allied Publishers Pvt.Ltd.
- P.C Pandey and H.S. Shan, Modern Machining Process, Tata McGraw Hill - ISBN:0070965536
- P.K. Mishra, Non-Conventional Machining, Narosa Publishing House.
- Gary F.Bendict, Non Traditional manufacturing Processes,CRC press, Taylors and Francis Group.

Reference Books:

- J.A. McGeough, Advanced Methods of machining Processes, Springer International Edition.
- F.M Wilson, High Velocity Forming of Metals, ASTME Pretice Hall.
- Adithan, Modern Manufacturing Method, New Age International (p) Limited -ISBN: 8122408176.
- Bijoy Bhattacharyya, Modern Machining Technology, Elsevier.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V
Course Code: ME359	Course Name: Operations Research

L	T	P	Credits
2	--	--	2

Course Description:

Operations research helps in solving problems in different environments that needs decisions. This course covers topics that include: Linear programming, Transportation, Assignment, Queuing theory, Inventory control, Replacement analysis and CPM/PERT techniques. Analytic techniques will be used to solve problems faced by business managers in decision environments.

Course Learning Outcomes:

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

1. Identify the breadth of quantitative decision situation that arise in engineering.
2. Develop skills needed for the mathematical modelling of real world decision situations.
3. Choose appropriate techniques and methodology to solve the problems.
4. Ability to work in a team specifically to solve the larger problems.

Prerequisite:

Basic knowledge of Engineering Management.

Course Content		
Unit No	Description	Hrs
1.	Linear Programming Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex and Big M method.	04
2.	Transportation and Assignment Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems. Assignment Problems and Travelling sales man Problem.	04
3.	Queuing Theory Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Preliminary examples of M/M/1:8/FCFA	04
4.	Inventory Control Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis.	04
5.	Replacement theory Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.	04





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Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

6.	Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.	04
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References:

Text Books:

- S. D. Sharma, Operation Research Theory, methods and application, Kedarnath ramnath Publisher.
- Purna Chandra Biswal , Optimization in Engineering, Scitech Publications Chennai.

References Books:

- Hamdy Taha , Operation Research , McGraw Hill Publications.





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

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T.Y. B. Tech Mech	Semester: V
Course Code: ME363	Course Name: Quality Management System

L	T	P	Credits
2	--	--	2

Course Description:

Quality Management System is a system that serves to control Quality in the critical activities of an organization by bringing together resources, equipment, people and procedures. It uses techniques and principles such as quality function deployment, Taguchi method, service quality management, quality audits and Six Sigma to control quality in every sphere of activity in an organization.

Course Learning Outcomes:

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

1. Explain the principles of Quality Management.
2. Discuss the role of quality management gurus in Quality Management.
3. Select and apply appropriate quality management tools and techniques for Quality assurance and control.
4. Describe quality management principles for service sector.
5. Discuss the importance of Quality management system in the organization.

Course Content

Unit No	Description	Hrs
1.	Basics of quality management Evolution of quality, Definition, Quality basics, Quality costs, Quality planning, Concept and Features of TQM, Elements of TQM, Benefits of TQM.	04
2.	Quality Management philosophy Deming Philosophy, Juran Philosophy, Crosby's Philosophy, Comparison of three major quality philosophies, Strategic quality planning, 7S approach to TQM culture, 5S, Kaizen.	04
3.	Quality Management tools Technique Benchmarking: Definition, concepts, benefits, elements, reasons for benchmarking, process of benchmarking, FMEA, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept and need, Seven QC tools.	04
4.	Quality assurance and Control Concept and objectives of quality assurance, Designing quality assurance system, Economic models for quality assurance, Process capability, six sigma, DMAIC, DMADV, Quality auditing and stages, Quality control. Overall Equipment Effectiveness (OEE)	04
5.	Quality management in services Quality in services, Difference between goods and services, Service quality-dimensions and determinants, Models for service quality, Return on service Quality.	04



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

6.	Quality Systems Role of standards in quality management system. ISO 9000, ISO 9000:2000, ISO 14000, other quality systems, ISO/TS 16949. ISO 45001.	04
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References:

Text Books:

- Dale H. Besterfield, Pearson, Total quality Management, Pearson Education
- Evans's. James, Lindsay M. William , The Management and Control of Quality, Cengage Learning
- Prof. K. Shridhara Bhat, Total Quality Management, Himalaya Publication House.

Reference Books:

- H.Lal, Lt. Gen ,Wiley Eastern Limited , Total Quality Management
- Bounds Greg , McGraw , Beyond Total Quality Management
- Kanishka Bedi, Oxford Higher Education, Quality Management





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3594	Course Name: Production and Operation Management	2	--	--	2

Course Description:

Production operation management is the process which combines and transforms various resources used in the production/operation subsystem of the organization into value added products/services in a controlled manner as per the policies of the organization. This course will help the students to learn recent concepts and tools used to manage the production/operations functions.

Course Learning Outcomes:

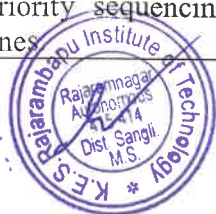
After successful completion of the course, students will be able to,

1. Select appropriate production and operation strategies based on situation.
2. Explain the strategic importance of product and service design.
3. Plan production activities using tools like capacity and aggregate planning.
4. Schedule the jobs so as to complete them in minimum make span time.
5. Apply recent production management trends like JIT and lean philosophy in manufacturing field.
6. Apply supply chain strategies for various industrial applications.

Prerequisite:

Basic knowledge of Production management.

Course Content		
Unit No	Description	Hrs.
1.	Basics of Production & Operations Management Introduction, Production of Goods versus Providing Services, Operation management functions, Key Issues for Today's Business Operations. Competitiveness, Production/operation strategy; Relevance, strategy formulation process, order qualifiers and order winners, attributes, Product portfolio.	05
2.	Product and Service Design Introduction, designing for mass customization, qualify function deployment, Kano model, Phases in Product Design and Development, Designing for production, Phases in service design, Differences between Service Design and Product Design.	04
3.	Capacity and Aggregate Planning Capacity- Definition, Measure of Capacity, capacity Overcapacity and under capacity factors, Aggregate Planning, Aggregate Planning Strategies, Pure and mixed strategies,	04
4.	Production Planning Loading, scheduling and sequencing, priority sequencing rules, sequencing problems, n job 2 machines, n job 3 machines	03





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

5.	JIT and Lean Manufacturing JIT philosophy, origin and core logic of JIT, elements of JIT, Kanban system, design of Kanban containers. JIT implementation issues and performance. Lean manufacturing; Pillars, features and process comparison with traditional manufacturing. Total productive maintenance, stages of maintenance, Overall equipment effectiveness (OEE), Replacement of items whose maintenance cost increases with time	04
6.	Supply Chain Management Concept of supply chain and supply chain management, Manufacturing supply chain, SCM activities, supply chain strategies, managing supply chain, measuring supply chain performance.	04

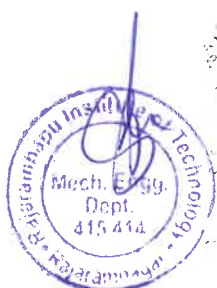
References:

Text Books:

- Martand Telsang, Industrial Engg and Production Management, S Chand & Company.
- Mahadevan, Production and Operations management, Pearson Education.

Reference Books:

- William J, Operations management, Mc Graw Hill.
- S. N. Chary, Production and Operations management, Mc Graw Hill.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)

Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch

Department of Mechanical Engineering

Program Elective-I

Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME361	Course Name: Sensors and Actuators in Robotic Technology	2	--	--	2

Course Description:

This course is designed to provide students with an in-depth understanding of the fundamental components that drive robotic systems - sensors and actuators. Students will explore the principles, types, and applications of sensors and actuators in the context of robotics.

Course Learning Outcomes:

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

1. Select the sensor for robotic application and design the systems.
2. Explain image processing technique
3. Select the actuators and configuring the parameters of Actuators.

Prerequisite:

Basic knowledge of Kinematic of mechanism, basic electrical engineering.

Course Content		
Unit No	Description	Hrs.
1.	Basics of Robotic system and sensors Types of robots, links and joints in robots, types of joints, end effectors, Introduction to sensors, characteristics of sensing devices, sensors classification, sensor calibration technique	03
2.	Sensors Pressure/contact. Resistive position. Infrared. Light. Position Sensors, optical encoders, proximity sensors, Range sensors, Ultrasonic sensors, Touch and Slip sensors. sensors for motion and position, Force, torque and tactile sensors, Flow sensors, Temperature sensing devices.	05
3.	Vision Sensors Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation.	05
4.	Advanced Sensor Technology Smart sensors, MEMS based sensors, Innovations in sensor technology, Actuators and its selection while designing a robot system. Types of transmission systems.	03
5.	Electric Actuators DC motor, Permanent magnet stepper motor, Servo Control DC motors, Linear and latching linear actuators, Rotary actuators, Piezoelectric actuators, Actuator parameters and characteristics, Stepper motors, Specifications and characteristics of Stepper Motors and Servo Motors.	04
6.	Pneumatic & Hydraulic actuators Hydraulic Actuators, selection of linear actuating cylinders, Hydraulic	04

	Motors, Pneumatic actuators, design considerations and selection, pneumatic cylinders, pneumatic drive system, Linear & rotary actuators. Advanced actuators – Piezoelectric actuators, elastomer actuators, soft actuators, shape memory alloy based actuators, under actuated robotic hand.	
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References:

Text Books:

- Ernest O Doebelin, Measurement systems- Applications and designs", Tata McGraw Hill
- D. Patranabis, Sensors and Transducers, PHI.
- Jon S. Wilson, Sensor Technology Handbook, Elsevier.
- Introduction to Robotics- John J. Craig, Addison Wesley Publishing

Reference Books:

- Mikell P Groover, Industrial Robotics - Technology, Programming and Applications, McGraw Hill.
- John Billingsley, Peter Brett, "Machine Vision and Mechatronics in Practice", Springer
- Braünl, T. Embedded robotics: mobile robot design and applications with embedded systems. Berlin; Heidelberg: Springer, 2008. ISBN 9783540705338.
- Martin, F.G. Robotic explorations: a hands-on introduction to engineering. Upper Saddle River, N.J.: Prentice-Hall, 2001. ISBN 0130895687.
- Gerard C., M. Meijer, Smart Sensors System, Wiley.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

Course Learning 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. Analyse 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* (Elsevier)





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 Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

Open Elective-I

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

Class: T. Y. B. Tech.	Semester: V	L	T	P	Credits
Course Code: OE3104	Course Name: Network Administration	3	-	-	3

Course Description:

This course is designed for the students from various academic backgrounds who wish to gain a fundamental understanding of network administration. The course covers essential network concepts and practical skills, with an emphasis on real world applications and everyday scenarios.

Course Learning Outcomes:

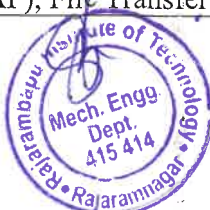
After successful completion of the course, students will be able to:

1. Recall and describe the different basic components of computer networks.
2. Explain the functions and interactions of each layer of the OSI model.
3. Distinguish various networking devices with their functions.
4. Analyze different web services and applications.
5. Synthesize the knowledge about cyber security related services and networking maintenance.

Prerequisite: Basic understanding of computer hardware and operating systems, Fundamental knowledge of networking concepts, Familiarity with the OSI model, Basic understanding of TCP/IP protocols.

Course Content

Unit No	Description	Hrs
1.	Introduction to Computer Networks Overview of computer networks (Components, Architecture), Importance of networking in various fields, types of networks (e.g. LAN, MAN, WAN), Common network terminologies (Topologies), Recent trends in network administration	6
2.	Basic Networking Protocols Operating System installation process (e.g. windows, Linux), Introduction to OSI Model (Application layer, presentation layer, Session layer, Transport layer, network layer, data link layer, physical layer), Networking hardware's (Router, Switches, Hubs), IP Addressing Basics (network class, network, subnet, and device)	6
3.	Connecting Devices Introduction to networking devices (e.g. NIC, Modems), Transmission media – Guided media, Unguided media (Wired and Wireless), Cabling and connectors (e.g. Coaxial and fiber optical Cables), Basics of Home Networking (A closer look at the Home Router, Components in a Home Router)	6
4.	Internet Services and Applications Introduction to web services (HTTP, HTTP's), Email and messaging protocols (SMTP, IMAP), File Transfer Protocol (FTP)	6





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

5.	Network Security Basics Introduction to cyber security (types of cybercrimes), Password Management (Generation of strong password, Enforces requirements), Firewalls and Antivirus software (Installation process of antivirus), Safe Internet Practices	6
6.	Troubleshooting and Basic Network Maintenance Introduction to network monitoring tools (Configuration, performance, cloud infrastructure), Basic troubleshooting techniques (Tips for troubleshooting computers), Regular Network Maintenance Practices, Future trends – Role of network in future - Real world examples	6

References:

Text Books:

- Seffrey S. Beasley and Piyasat Nilkaew "Network Essentials" Pearson Publishing.
- William Stallings "Network Security Essentials" Pearson Publishing

Reference Books:

- Craig Hunt "Network Administration: The Complete Guide to Network Security and System Administration".





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Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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.

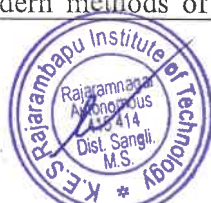
Course Learning Outcomes:

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 warming, Sea Level rise, Ozone Depletion.	06
2.	Manmade Disasters Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disasters -A Global View, Disaster Profile of India- Regional, and Seasonal.	06
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,	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

References:

Codes of Practice:

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

Text Books:

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

Reference Books:

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

Course Learning Outcomes:

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

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

Prerequisite:

Electric Machines, Thermal Systems and Finance Management

Course Content

Unit No	Description	Hrs
1.	Energy Scenario Energy Needs of Growing Economy; Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment, Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features.	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.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

Course Learning Outcomes:

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

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

Prerequisite: Basic Mathematics, Descriptive statistical techniques

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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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 Steinbach, "Introduction to Data Mining", Pearson Education.
- Brian 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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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
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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.



Open Elective-I

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

Course Description:

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

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

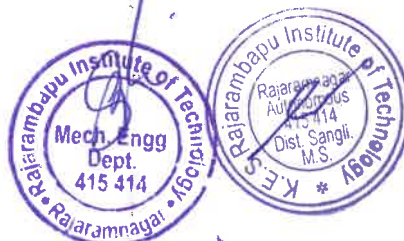
Course Learning Outcomes:

After successful completion of the course, students 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 the 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:

- Devdas Shetty, Design for product success, Society for Manufacturing Engineering.

Reference Books:

- Ulrich, Eppinger, Anita Goel, Product Design and Development, McGraw Hill Publishing.
- Otto & wood, Product Design, Pearson Education, reprint.
- Charles Flurscheim, Industrial Design in Engineering, the Design Council, London.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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:

After successful completion of the course, students will 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 Photovoltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications	06
3.	Bio - Energy Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Biodiesel – 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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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.

Reference Books:

- 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.





K.E. Society's
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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

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 boards and stationary applications	06
4.	Fuel cells Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages, different types of fuel cells and applications, characteristics, Nernst equation, relation of the fuel consumption versus current output	06
5.	Membranes & Fuels for Fuel Cells Membranes: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments. 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
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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.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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. Recognise 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. Analyse 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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

6.	Case Study Factory automation in manufacturing industry and Process Industry.	06
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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.





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

Course Learning Outcomes:

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

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

Prerequisite: NA

Course Content		
Unit No	Description	Hrs
1.	Computational foundation of Cyber Physical Systems Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, Industry 4.0, IIoT. Introduction Toward Industry 5.0: Cognitive Cyber-Physical System	06
2.	Cyber Physical System Design Cyber Physical Systems Design Recommendations, CPS system requirements, Cyber Physical System Application, Case study of Cyber Physical Systems.	06
3.	Cyber Physical System Platforms & Models Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems.	06
4.	Cyber Physical System – Models and Dynamics Behaviors Continuous Dynamics, Discrete dynamics, Hybrid Systems	06
5.	Concurrent Models of computation Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation	06



6.	Security and Privacy in Cyber Physical Systems Security and Privacy Issues in CPSs, Cyber Security Laws in India: IT Act (2000), IPC(1980), Companies Act (2013), Local Network Security for CPSs, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cyber security in Digital Manufacturing/Industry 4.0	06
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References:

Text Books:

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

Reference Books:

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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Text Books:

- Arshdeep Bahga, Vijay Madiseti., " Internet of Things – A hands On Approach," 1st Edition, 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,2018.
- Alessandro Bassi," Enabling Things to Talk- Designing IoT solutions with the IoT Architectural Reference Model", Springer.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

Course Learning Outcomes:

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

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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
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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.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

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

Course Description:

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

Course Learning Outcomes:

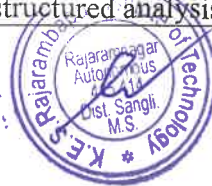
After successful completion of the course, students will be able to,

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:

Basics 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, System design with examples, combining models, designing models, Comparing Methodologies using structured 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 chart diagrams, Case Study on use case, interaction, activity and state chart diagrams.	06
6.	Architectural Modeling using UML Components, Deployment, Collaboration, Patterns and Frame works, Component diagrams and Deployment Diagrams, Case Study on Components, Deployment, Collaboration diagrams.	06

References:

Text Books:

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

Reference Books:

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-I

Class: T. Y. B. Tech	Semester- V	L	T	P	Credits
Course Code: OE363	Course Name: Robotics Engineering Application	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 Learning Outcomes:

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

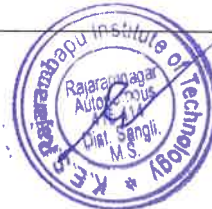
1. Explain various applications of robotics in industry and society.
2. Describe the concept of automation, robot integration, and their role in Industry 4.0.
3. Investigate the use of robots in healthcare, agriculture, defence, service, and space exploration.
4. Discuss ethical considerations and future 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	06
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.	06
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).	06
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.	06



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

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)	06
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. Case study on Ethical Considerations.	06

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)





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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.

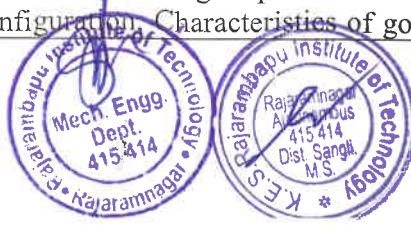
Course Learning Outcomes:

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 its component parts.
5. Summarize 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 surface drainage; PPP in Transport Sector	06
4.	Airport Engineering Introduction: Advantage and limitation of air transportation, Aircraft component parts and characteristics, Important terms in Airport planning, Airport layout: Imaginary surfaces, Zoning requirements, Runway Location and orientation, Runway configuration, Characteristics of good layout, Basic	06



	runway length, Use of wind rose diagram. Airport Lighting and Markings.	
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.



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

This course serves as an introduction to the fundamental principles and practices of database management. It is designed for individuals seeking to develop a solid foundation in organizing, storing, retrieving, and managing data efficiently. Participants will gain both theoretical knowledge and hands-on experience in working with databases, providing a comprehensive understanding of modern database management systems.

Course Learning Outcomes:

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

1. Describe the purpose and nature of the database system for storing and fast access to the data
2. Identify various protocols, issues, and techniques related to transaction management for a consistent & and stable database
3. Draw E-R models to represent simple database application scenarios
4. Design the queries to manipulate and access data using procedural and non-procedural languages
5. Apply relational database design concepts to remove data redundancy and to retrieve data easily
6. Perform operation on Unstructured data.

Prerequisites:

Basic understanding of computer science concepts and familiarity with basic programming principles, basic Knowledge of File System & Client server Architecture.

Course Content		
Unit No	Description	Hrs
1	Introduction and Database concepts and Data Model Purpose of Database Systems, Data abstraction, Data Models, Overall System Design, Entities and Entity sets, Mapping Constraints, E-R Diagram, Reducing ER Diagrams to Tables, Generalization, specialization and Aggregation, Relational Algebra, Tuple Calculus.	06
2	Structured and Procedural Query Language Introduction to SQL and PL/SQL, Set operations, Joins, Aggregate operations, Nested queries etc., PL/SQL Cursor, stored procedure and Trigger.	06
3	Relational Database Design Domain Constraints, Referential Integrity, Functional Dependencies, Canonical cover, Pitfalls in Relational Database Design, Decomposition and Normalization using Functional Dependencies.	06
4	Transaction Management and Concurrency Control Basic concepts, States, Concurrent execution, Serializability, Recoverability, isolation; Concurrency control: Timestamps and locking protocols, Validation	08





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	based protocols, deadlock handling; Recovery: Log-based recovery, Shadow-paging.	
5	Database Security and Crash Recovery Introduction to Database Security, Confidentiality, Integrity, Availability Needs of Database Security SQL injection attack, error recovery and logging undo, redo, undo-redo logging, and recovery methods.	06
6	Introduction to NoSQL Database Fundamentals of NoSQL (NoSQL Features, Data Models, and Distribution Models), Introduction to MongoDB, MongoDB CRUD operations. (Creating, Reading & Updating Data)	04

References:

Text Books:

- Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database system concepts", Fifth Edition, McGraw Hill International Edition, ISBN 978-0073523323.
- Raghu Ramkrishnan, Johannes Gehrke, "Database Management Systems", Third Edition, McGraw Hill International Editions, ISBN 978-0072465631.

References:

- Ramez Elmasri and Shamkant B. Navathe, "Fundamental Database Systems", Third Edition, Pearson Education, ISBN 978-0321204486.
- Kristina Chodorow, "MongoDB: The Definitive Guide: Powerful and Scalable Data Storage".Third Edition





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech.	Semester- V	L	T	P	Credits
Course Code: EEMD301	Course Name: Electrical Machines	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:

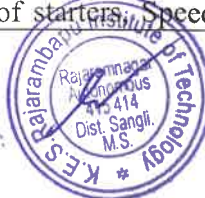
After successful completion of the course, students will be able to,

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, Torque-Slip characteristic of 3-Phase Induction motor, Need and types of starters, Speed Control of 3-	06



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

References:

Text Books:

- 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



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

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 min-Wave MIMO Systems.	06
6.	Communication Techniques Fundamentals of Fiber Optics Communication, GSM, CDMA, LTE, Blue	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	Tooth, WiFi, ZigBee, LoRA, RFID.	
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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 to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.

Reference Books:

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech	Semester: V
Course Code: CIMD301	Course Name: Introduction of 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. data. A general-purpose DBMS is a software system designed to allow the definition, creation, querying, update and administration of databases

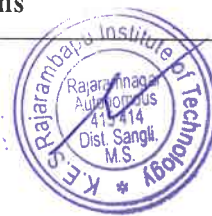
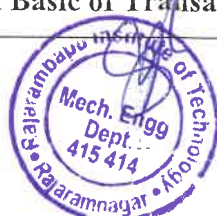
Course Learning Outcomes:

After successful completion of the course, 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 principle 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	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	Overview, Query Interpretation, Concepts of transaction processing, ACID properties, Transaction states, Serializability, Testing for serializability.	
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, Johanes Gehrke, "Database Management Systems", McGrawHill Education.

Reference Books:

- J.D. Ullman, "Principles of Database Systems", Galgotia Publications.
- Jio Wiederhold, "Database Design", McGraw Hill International.
- Kristina Chodorow, "MongoDB: The Definitive Guide: Powerful and Scalable DataStorage".





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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:

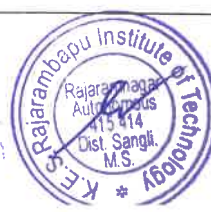
This course introduces students to the fundamental and advanced tools and techniques used in product design, focusing on engineering principles, design for manufacturability, value engineering, concurrent engineering, reverse engineering, and prototyping. The course will combine theoretical foundations with practical applications, including case studies.

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 reverse engineering on a product.
5. Apply various prototyping techniques, including rapid prototyping technologies.

Course Content		
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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

5.	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.	06
6.	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

References:

Text books:

- Engineering Design Principles, Kenneth S. Hurst, Butterworth-Heinemann.
- Kathryn, 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.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

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

Course Learning Outcomes:

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

1. Understand the fundamental principles of various sensors and transducers.
2. Analyze the characteristics, advantages, and limitations of different sensor types.
3. Apply appropriate signal conditioning techniques to improve sensor output accuracy and integrate sensors into mechatronic systems for real-time data acquisition and control.
4. Select appropriate sensors for specific mechatronic systems used in 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	06



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	Photodiodes, Phototransistors, Image sensors (CMOS, CCD) Wireless and IoT Sensors Bluetooth, Wi-Fi, Zigbee, and other wireless protocols, Integration of sensors into IoT platforms.	
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:

Text Books:

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

Reference Books:

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



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

Course Description:

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

Course Learning Outcomes:

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

1. Utilize machine learning techniques and understand the basic theory underlying machine learning.
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, Under fitting, 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.	
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	08
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 disadvantages of K-means clustering, Distance measures.	06
6	Bayesian learning Classical, Empirical, Subjective methods, Types of events, Types of probabilities, Normal Distribution, Bayes' Theorem, Naïve Bayes' classifier.	06



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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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 and Francis Publication





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech.	Semester: V	L	T	P	Credits
Course Code: RAMD301	Course Name: Kinematic & Dynamics for Robots	3	-	-	3

Course Description:

This course provides an opportunity for the students of other engineering programs to learn kinematic and dynamic analysis of the robots. The fundamental concepts of mechanisms and methods of mechanism design and selection are introduced. The course covers the concepts of kinematic and dynamic analysis of robots such as forward kinematics, inverse kinematics and robot dynamics. The robot grippers, manipulators, their dynamic analysis and workspace analysis is also covered in the course. The course outcomes will ultimately help to perform synthesis of mechanisms and kinematic and dynamic analysis of different robots for various applications.

Course Outcomes:

After completion of this course student will be able to -

1. Select the type of mechanism for the robotic applications.
2. Perform kinematic analysis and synthesis of mechanisms.
3. Perform forward and inverse kinematics of robots.
4. Perform workspace analysis for different types of robots.
5. Design robot manipulators based on dynamic analysis.
6. Perform forward and inverse dynamics of robots.

Prerequisite: Kinematics of Machines, Dynamics of Machines

Course Content:		
Unit No	Description	Hrs
1.	Fundamental Concepts Kinematic Links, kinematics pair, types of constrained motion, Kinematic chain, Degrees of freedom, mechanisms, inversion of mechanism, position and orientation of rigid body, Linear and angular velocity of links, Velocity propagation, synthesis of mechanisms	06
2.	Forward Kinematics Robot kinematics, D-H representations and displacement matrices for standard robot configurations, The ARM equation, Forward kinematics of manipulators up to 6 degrees of freedom, representation of forward kinematic equations. Direct kinematic analysis for Four axis, SCARA Robot and three, five and six axis Articulated Robots.	06
3.	Inverse Kinematics Inverse kinematic analysis of robot with standard configurations, methods for solution of non-linear simultaneous equations, singularity analysis, Inverse kinematic solution of Robots - Inverse kinematics of four axis SCARA robot and three and five axis Articulated robot.	06
4.	Workspace Analysis	06



	Workspace analysis, work envelope of a Four axis SCARA robot and five axis articulated robot, workspace fixtures, the pick and place operations, Joint space technique – continuous path motion, Interpolated motion, straight line motion and Cartesian space technique in trajectory planning,	
5.	Robot End Effectors Classification of the Robot End effectors- tools and grippers, selection and Design consideration of the gripper, mechanical grippers, vacuum grippers, magnetic grippers, adhesive grippers, RCC grippers, gripper force analysis, Materials for hostile operation of gripper. Tools used as end effectors- welding gun, spray gun, drilling tool etc., Tool center point (TCP)	06
6.	Manipulator Dynamics Kinetics of rigid bodies – Work energy principle, Linear and angular momentum, conservation laws, Forward Dynamics and Inverse Dynamics, Spatial description and transformations, Dynamic parameters identification, Newton-Euler formation, Lagrange-Euler formation, Dynamic model of simple manipulator structures , Dynamic model of a Two-axis planar robot	06

References:

Text Book-

- Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology- Programming and Applications", McGraw Hill Book Co.
- S. K. Saha, Introduction to Robotics, TATA McGraw Hills Education.
- S.S.Ratan , Theory of Machines, Tata McGraw Hill.

Reference Books:

- Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning.
- Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering: An Integrated Approach, PHI Learning.
- Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc.
- Bernard Hodges, Industrial Robotics, Second Edition, Jaico Publishing house.
- Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press.
- John J. Craig, Introduction to Robotics Mechanics and Control, Pearson.
- 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, —Conrol of Robot Manipulators in Joint Space, Springer.
- John J. Craig, Introduction to Robotics, Addison Wesley, ISE.



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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech	Semester: V
Course Code: CEMD303	Course Name: Smart Cities & 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.
1.	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
2.	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
3.	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
4.	Resilience and Sustainable Development Sustainable Development Introduction, Origin, Definition, three pillars of	04

	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.	
5.	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
6.	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
Course Code: CSMD303	Course Name: Object-oriented Programming in Python

L	T	P	Credits
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:

At the end of the course the student should 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.

Prerequisites:

Basic understanding of programming concepts.

Course Content		
Unit No	Description	Hrs
1	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
2	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
3	Classes and Objects Classes, objects, parameterized and non-parameterized init constructor, object methods, self-parameter, association, Access modifiers: Private, public, protected	02
4	OOP Concepts Inheritance, Encapsulation, Polymorphism: overloading and overriding, abstraction: interface and abstract class.	02
5	File handling and Exception File handling syntax, read files, write/create files, delete files, handling runtime exception and custom exception.	02
6	Modules and Libraries Introduction, modules using dir() function, Numpy, Pandas, Matplotlib,	02



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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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	L	T	P	Credits
Course Code: EEMD303	Course Name: Electrical Technology	1	-	2	2

Course Description:

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

Course Learning Outcomes:

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

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
1	Power Electronic Device Power diode, BJT, Thyristor, MOSFET, IGBT: Structure, Symbol, Working Principle, Comparison.	02
2	Power Electronic Circuits Rectifier: single phase full wave diode rectifier, Chopper: basic step-down and step-up Chopper, Inverter: single phase full bridge inverter.	02
3	Electrical and Electronic Measurements Electrical instruments, characteristics of measuring instruments, standards of measurement, voltmeter, ammeter and wattmeter, digital multi-meter, power analyzer. Comparison of analog and digital meters.	02
4	Transducers Introduction, Classification of Transducers, Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Measurement of weight, speed, temperature, pressure and flow.	02
5	Solar and Wind Energy Systems Solar cell fundamentals, V-I characteristics of a PV panel, principles of wind energy conversion, components of wind energy conversion system, classification of wind turbines- horizontal axis and vertical axis. Wind power integration into grid-power system, grid connected PV systems	02
6	Electric Vehicle What Is an Electric Vehicle? Engineering philosophy of EV development, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle, Overview of EV Technologies.	02

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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

References:

Text Books:

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

Reference Books:

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





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

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

Course Learning Outcomes:

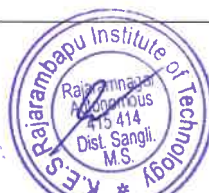
After successful completion of the course, students will be able to,

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
1.	Product Design and Development Introduction, Product Development Basics, Product Development Stages, Identification of the Customer Requirements, Techno-Commercial Feasibility of a Product, Pilot Production Batch, Product Assessment, Availability, Screening Test of Component, Redundancy, Ergonomic and Aesthetic Design Considerations	04
2.	Noise and Heat Management Power Supply Protection Devices, Transient Voltage Suppressor, Fuses, Line Filters, Noise Consideration of a Typical System, Noise in Electronic Circuits, Grounding, Shielding, Guarding, Thermal Management.	04
3.	PCB Design Introduction to PCBs, Layout, Issues Related to PCB Size, Design Issues Related to Supply and Ground Conductors, Multilayer Boards, Component Assembly Techniques, Comparison of PCBs.	04
4.	Hardware and software Design and Testing Methods Introduction, Signal Integrity, Software Design and Testing Methods, Phases of Software Design, Selection of Language for Software Development, Assemblers, Compilers, Simulators, Emulators.	04
5.	Electronic Product Testing 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



6.	Product Documentation Introduction, Types of Documentation, How to Prepare an Effective Document, PCB Documentation, Bill of Material: A Documentation of Part List, Manual Types.	04
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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.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

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

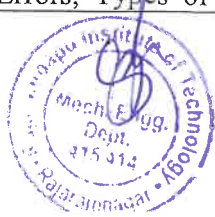
Course Learning Outcomes:

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

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
1.	Introduction to Java Programming Java buzzwords, Features of Java, JDK, JRE and JVM, Variables and data types, I/O statements in Java, Conditional and looping statements, Arrays.	02
2.	Introduction to Object-Oriented Programming Features of object-oriented programming, Class and objects, Constructors, Method and constructor overloading, Nested classes.	02
3.	Features of Object-Oriented Programming Polymorphism: Method overloading (Compile time Polymorphism), Method overriding (Run time Polymorphism), Inheritance, super, this, static and final keywords, Abstraction, Interface, Garbage collection.	02
4.	Collection and String Collection, Collection Framework, List: ArrayList, LinkedList, Vector and Stack, Queue: Deque and Priority Queue, Set: TreeSet and HashSet, Map: Hash Table and Hash Map, Java String.	02
5.	Exception Handling Exceptions & Errors, Types of Exception, Control Flow in Exceptions,	02



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

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

References :

Text Books:

- 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.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

L	T	P	Credits
2	--	--	2

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:

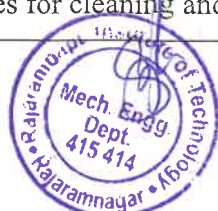
After successful completion of the course, students will be able to,

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.	02
2.	Advanced Sketching Techniques Using geometric constraints, Parametric sketching techniques, Practice exercises on complex shapes.	02
3.	Basic Part Design Extruding and revolving sketches, Introduction to editing features like fillets, chamfers, and shells.	02
4.	Advanced Part Design Applying advanced features and reference geometries, Transformation feature-Patterning, Scaling, Mirror, Creating assemblies from multiple parts.	02
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.	04
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.	02





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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
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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 Schöffner, 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
1.	Programmable Logic Controllers Introduction - Parts of PLC - Principles of operation - PLC sizes - PLC hardware components - I/O section - Analog I/O modules - digital I/O modules CPU processor memory module - PLC programming Simple instructions - Output control devices - Latching relays PLC ladder diagram,	04
2.	Instructions Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters.	04
3.	Application of PLC Traffic light control, 24-hour clock design, Automatic stacking process, temperature control, Automatic control of warehouse door,	04
4.	Networking of PLC and SCADA Networking of PLCs-Data Communication-Fieldbus, PROFI bus, and Mod bus-OSI. Supervisory Control and Data Acquisition-Architecture.	04
5.	Distributed Control System Architectures - Comparison - Local control unit, Operator interfaces - Low level and high-level operator interfaces - - Low level and high-level engineering interface	04
6.	Applications of DCS Pulp and paper environment -Power plant - Petroleum - Refining environment, Wireless control system in challenging environments like welding shops, Introduction to Soft PLC.	04



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Reference Books:

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





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Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

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.

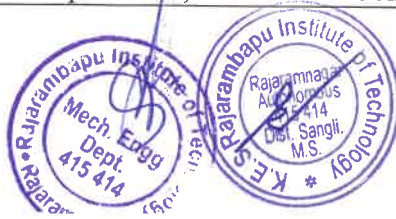
Course Learning Outcomes:

1. Articulate data pre-processing techniques
2. Analyze the data modeling required for business intelligence related tasks
3. Determine the role of statistical techniques in data analysis tasks
4. Identify big data analysis techniques
5. Utilize different reporting/visualization tool

Prerequisites:

1. Database Management Systems
2. Basic Probability and Statistics

Course Content		
Unit No	Description	Hrs
1	Introduction What is business intelligence (BI)? Need for BI. Drawing insights from data: DIKW pyramid, levels of decision making (strategic, tactical and operational BI). Examples of business analyses–funnel analysis, distribution channel analysis and performance analysis.	05
2	Data Preprocessing Notion of data quality. Typical preprocessing operations: combining values into one, handling incomplete/ incorrect / missing values, recoding values, sub setting, sorting, transforming scale, determining percentiles, removing noise, removing inconsistency, transformations, standardizing, normalizing - min-max normalization, score standardization.	04
3	Inferential Statistics Role of probability in analytics, probability distributions and their characteristics. Need for sampling, generating samples, sampling and non-sampling error. Sampling Distribution of Mean, Central Limit Theorem, Standard Error. Estimation: Point and Interval Estimates, Confidence Intervals, level of confidence, sample size.	04
4	Data Warehousing What is a data warehouse, need for a data warehouse, architecture, data marts, OLTP vs OLAP, Multidimensional Modeling: Star and snow flake schema, Data cubes, OLAP operations, Data Cube Computation and Data	04



	Generalization, Data Lake	
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:

- Business Analytics by James R Evans, Pearson
- Data Mining: Concepts and Techniques”, Jiawei Han and Micheline Kamber, Morgan Kaufman, ISBN 978- 81-312-0535-8, 2nd Edition for overview of data mining, OLAP and cube technology, data preprocessing
- Fundamentals of Business Analytics”, by R. N. Prasad, Seema Acharya, ISBN: 978-81-256-3203-2, Wiley-India – Types of Digital Data, OLTP-OLAP, Introduction to BI
- Business Analytics for managers, Wolfgang Jank–exploring and discovering Data Modeling

Reference Books:

- Business Intelligence for Dummies
- Applied Business Statistics: Making Better Business Decisions(English) 7 th Edition by Ken Black, Wiley India
- Forecasting: Principles and Practices, Rob J Hyndman, George Athanasopoulos, Otext





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech.	Semester: V	L	T	P	Credits
Course Code: RAMD303	Course: Robot Programming	1	--	2	2

Course Description:

This course provides a comprehensive introduction to robot programming techniques and control strategies. Students will learn how to program robots to perform various tasks autonomously and interact with their environment using robot operating system. This course covers Robot programming fundamentals, motion planning and control, Robot simulation and testing.

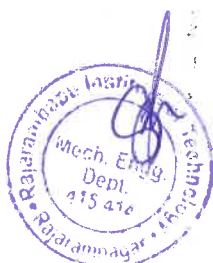
Course Outcomes:

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

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, Lead through method. Robot program as a path in space, Methods of defining positions in space, Motion interpolation, branching.	03
2.	Robot programming languages Categories of Robot programming languages. Modes of operation of robot programs. Requirements for a standard robot language, Robot programming Language Structure, Elements of Robot programming Language. Functions in Robot programming Language.	03
3.	Robot Operating System (ROS): ROS functionalities, ROS structure, Distribution, Tools, Architecture, Philosophy, workspace, Nodes, Packages, Topics. The ROS Graph.	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. Robot Programming using teach Pendant for various applications	03





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

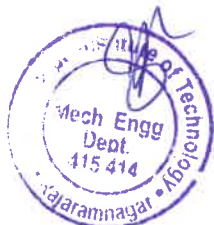
List of experiments (Any 10)

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:

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.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: Third Year B. Tech	Semester: V
Course Code: ME 315	Course Name: Design of Machine Element

L	T	P	Credits
3	--	--	3

Course Description:

Design of Machine Elements introduces to the systematic methodology of designing mechanical components for optimal performance, safety, and manufacturability. The course emphasizes the integration of theoretical principles with practical design considerations, including material selection, failure analysis, and adherence to industry standards. Students will develop competence in designing essential machine elements including joints, shafts, springs, couplings, and power transmission components while considering economic, aesthetic, and ergonomic factors.

Course Learning Outcomes:

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

1. Apply fundamental design principles, standards, material selection, and DFMA practices to develop machine elements.
2. Analyze mechanical components under static loading using failure theories.
3. Design bolted and welded joints under various loading conditions.
4. Design machine components such as shaft, keys, couplings, helical springs and power screws.

Prerequisite:

Strength of Material, Engineering Mechanics, Engineering Materials, and Engineering Mathematics

Course Content		
Unit No	Description	Hrs.
1.	Fundamental aspects of design Engineering design and classification, basic design procedure, requirement of machine element, standards and codes, selection of preferred sizes, aesthetic and ergonomic considerations in design, manufacturing considerations in design, design for manufacture and assembly, engineering materials and classification, selection of engineering materials for given application.	06
2.	Design against static load Modes of failure, stresses due to bending and torsional load, Theories of elastic failure: maximum principal stress theory, maximum shear stress theory, distortion-energy theory, selection and use of failure theories, design of lever, design of cotter and knuckle joints.	06
3.	Design of temporary and permanent Joints Design of bolted joint: forms of screw threads, terminology of screw threads, bolted joint simple analysis, eccentrically loaded bolted joint in shear, eccentric load perpendicular to axis of bolt Design of welded joint: types of welded joints, strength of butt welds, strength of parallel fillet weld, strength of transverse fillet weld, eccentric load in plane of welds, weld subject to bending moment and torsional moment.	06



4.	Design of shaft and keys Shaft: types of shafts, design of solid & hollow shafts on strength and rigidity basis, A.S.M.E code for shaft design Keys: types of keys, design of square and flat keys, splines	06
5.	Design of spring and couplings Spring: types of springs, terminology, stress and deflection equation, spring material, design of helical Spring, Couplings: design of muff coupling, clamp coupling and rigid flange coupling	06
6.	Design of power screw Forms of thread, torque requirement – lifting load and lowering load, self-locking screw, efficiency of square threaded screw, design of power screw & nuts	06

References:

Text Books:

- V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication.
- S. P. Patil, Mechanical System Design, Jaico Publication House, New Delhi.
- S. K. Basu and D. K. Pal, Design of Machine Tools, Oxford and IBH Publication.
- N. K. Mehta, Machine Tool Design, Tata McGraw Hill Publication.

Reference Books:

- Shigley and C. R. Mische, Mechanical Engineering Design, Tata McGraw Hill Publication.
- R. L. Norton, Machine Design – An Integrated Approach, Pearson Education.
- Juvinall R. C. and Marshek K. M., Fundamentals of Machine Component Design, Wiley India.
- Spotts M. F., Shoup T. E., Design of Machine Elements, Pearson Education.



Class: T.Y. B. Tech Mech	Semester: V
Course Code: ME3214	Course Name: Heat and Mass Transfer Lab

L	T	P	Credits
--	--	2	1

Course Description:

The Heat and Mass Transfer Laboratory course provides hands-on experience in applying theoretical principles of heat transfer. Students engage in practical experiments to study conduction, convection, and radiation phenomena. The laboratory sessions involve the measurement and analysis of heat transfer coefficients, thermal conductivity, through experimentation and data analysis, students gain insights into the practical aspects of heat and mass transfer, reinforcing their theoretical knowledge. This course enhances students' skills in conducting experiments, collecting data, and interpreting results, preparing them for real-world applications in engineering and related fields.

Course Learning Outcomes:

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

1. Determine the thermal conductivity of materials and compute heat conduction through a fin and a composite wall.
2. Compute heat transfer coefficient in natural as well as forced convection environment.
3. Determine the emissivity and Stefan-Boltzmann constant for radiative heat transfer
4. Compare the performance of heat exchanger
5. Determine critical heat flux of material/Examine film wise and drop wise condensation phenomenon

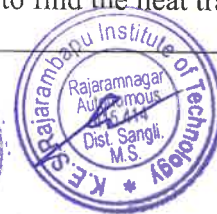
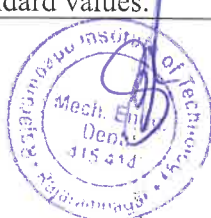
Prerequisite:

Students should know concept in thermodynamics, fluid mechanics, and engineering mathematics.

Course Content

Attempt any 10 experiments from the following list

Expt. No.	Description	Hrs.
1	Conduct an experiment to determine the thermal conductivity of a metal rod.	2
2	Perform an experiment to find the thermal conductivity of an insulating powder.	2
3	Analyze heat transfer in a composite wall experimentally and compare it with theoretical predictions.	2
4	Evaluate heat transfer from a pin fin through experimental investigation.	2
5	Experimentally determine the emissivity of an unknown surface.	2
6	Experimentally measure the Stefan-Boltzmann constant.	2
7	Conduct a forced convection experiment to determine the heat transfer coefficient and compare it with established standards.	2
8	Perform a natural convection experiment to find the heat transfer coefficient and compare it with standard values.	2



9	Perform experiments on parallel-flow and counter-flow heat exchangers, comparing their respective performances.	2
10	Conduct experiments on shell-and-tube-type heat exchangers and compare their performances.	2
11	Conduct experiments on plate-type heat exchangers and compare their performances.	2
12	Experimentally determine the critical heat flux and compare it with established standards.	2
13	Perform experiment on film wise and drop wise condensation phenomenon	2

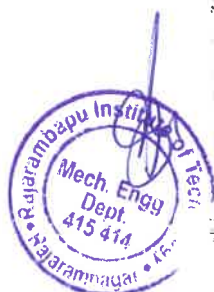
References:

Text Books:

- R.K. Rajput, Heat and Mass Transfer, S. Chand and Company Ltd., New Delhi.
- Dr. D. S. Kumar, Heat and Mass Transfer, S.K. Kataria and Sons, Delhi.
- P.K. Nag, Heat Transfer, Tata McGraw Hill publishing Company Ltd., New Delhi

Reference Books:

- R.C. Sachdev Heat and Mass Transfer, Tata MacGraw Hill Publisher.
- J.P.Holman Heat Trasfer, Tata MacGraw Hill Publisher.
- M.Necati Ozisik A Basic Approach to Heat Transfer, Tata MacGraw Hill International Edition.
- Ynus A Cengel, Heat Transfer a Practical Approach, Tata MacGraw Hill.



Class: T.Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3234	Course Name: Kinematics and Dynamics of Machines Lab	--	--	2	1

Course Description:

This laboratory course is designed to prepare the student to understand and apply the skills and knowledge of Kinematics of machines and dynamics of machinery to resolve the issues arises due to dynamic forces while designing as well as operating machines and mechanical systems. The practical's includes hands on to find moment of inertia, characteristics of governor, balance rotary masses, evaluate gyroscopic effect, estimate modal parameters of vibrating system, measure vibrations and estimate response of system subjected to harmonic force.

Course Learning Outcomes:

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

1. Estimate moment of inertia of Irregular shape bodies.
2. Analyse the controlling force and stability of governor.
3. Investigate the stability of spinning bodies due to gyroscopic effect.
4. Apply the theoretical knowledge to balance the rotary systems
5. Determine the natural frequency, vibration level, damped frequency and resonant frequency of any vibratory system
6. Recognize the whirling speed conditions of shaft and methods to eliminate it

Prerequisite:

Applied Mechanics, Engineering Mathematics viz. Differential Equations and its Solution

Course Content

Note: Any 10 experiments from the list

Experiment No	Description	Hrs
1.	Determination of Mass Moment of Inertia using bifilar suspension	02
2.	Verification of angular velocity ratio of universal joints	02
3.	Estimation of characteristics of Porter governor	02
4.	Generation of Involute gear tooth profile.	02
5.	Balancing of masses rotating in same plane	02
6.	Balancing of masses rotating in different planes	02
7.	Find Gyroscopic effect of spinning body	02
8.	Find damping factor of given system by Logarithmic Decrement method.	02
9.	Find forced vibration characteristics of given Spring-mass-damper system.	02
10.	Find out critical speeds and corresponding mode shapes of rotating shaft.	02

11.	Measure overall vibration level of given machine	02
12.	Open ended project consist of identifying links, pairs, mechanisms, degree of freedom and its analysis using appropriate methods studied, using software as well as building model using MAKIT Kit.	02

References:

Text Books:

- Rattan, S.S, Theory of Machines, Tata McGraw-Hill Publication
- P.L.Ballany, Theory of Machines& Mechanism, Khanna Publication
- S Graham Kelly, Fundamentals of Mechanical Vibrations, Tata McGraw-Hill Publication
- G.K. Groover, Mechanical Vibrations, Nemchand & Brothers

Reference Books:

- V.P. Singh, Theory of Machines, Dhanpat Rai and Sons
- Shah and Jadhawani, Theory of Machines, Dhanpat Rai& Sons
- Abdullah Shariff, Theory of Machines, McGraw Hill
- Uicker, J.J., Pennock G.R and Shigley, J.E., Theory of Machines and Mechanisms, Oxford University Press
- Thomas Bevan, Theory of Machines, CBS Publishers and Distributors
- Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill Publication
- S. S. Rao, Mechanical Vibrations, Pearson Publication
- Pujara K, Vibration & noise for Engineering, Dhanpat Rai and Company



Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3254	Course Name: Software Training Lab-I : NX-CAM	--	--	2	1

Course Description:

This course enables students to create 3D CAD models of engineering components using Simens NX software. Students will import these models into the CAM environment of the software and can generate and simulate tool path for machining of these components on CNC machines. Students can also generate the process sheet and part programs for the machining of these components.

Course Learning Outcomes:

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

1. Develop the sketches for the engineering components
2. Develop the part model for the engineering components
3. Generate the toolpath for the machining of engineering component on CNC machines.
4. Simulate the toolpath for the machining of engineering component on CNC machines.
5. Generate process sheet and CNC part programs.

Prerequisite:

Basic knowledge of engineering drawings, machining processes, CNC machines.

Course Content		
Expt . No.	Description	Hrs.
1.	Introduction to NX CAD/CAM	02
2.	Developing sketches - I Sketching environment, sketching tools, adding constraints and dimensions to the sketches	02
3.	Developing sketches - II Sketching environment, sketching tools, adding constraints and dimensions to the sketches	02
4.	Developing solid models – I Editing, extruding and revolving the sketches, working with the fixed and relative datum planes.	02
5.	Developing solid models – II Creating holes, grooves, slots, edge chamfers, edge blends	02
6.	Developing solid models – III Working with the instance feature tool, creating tubes or cables, creating threads	02
7.	Developing solid models – III Sweeping the sketches	02
8.	Assembly modeling	02



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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

9.	Drafting	02
10.	Generate tool path and part program for plain milling operation	02
11.	Generate tool path and part program for contour milling operation	02
12.	Generate tool path and part program for turning operation	02

References:

Text Books:

- Dr. Ming C. Leu, Albin Thomas, NX .9.0 for engineering Design by, Krishna kolan
- Sham Tickoo, NX .9.0 for Engineering Design by Tata MacGraw Hill Publication.
- Yunus A. Cengel, Thermodynamics an Engineering Approach, Tata McGraw Hill.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3254	Course Name: Software Training Lab-I: NX-CAD	--	--	2	1

Course Description:

This course is designed to equip students with the knowledge and skill required to effectively use Siemens NX software. The course covers the fundamental of 2D sketching, 3D modelling, assembly design and drafting. Student will gain hands on experience in creating detailed designs and understanding the principles of parametric design.

Course Learning Outcomes:

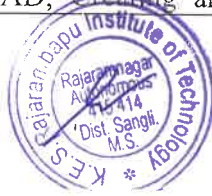
After successful completion of the course, students will be able to,

1. Use NX CAD module for the 3D modelling and assembly.
2. Create the detailed drawing of machine components including GD&T.

Prerequisite:

Basic knowledge of engineering drawings.

Course Content		
Expt. No.	Description	Hrs.
1.	Basics of NX CAD Interface Overview of the NX CAD environment, workspaces and menus	02
2.	Basic 2D Sketching and Drawing Coordinate system, datum planes, creating basic 2D sketches, adding constraints, editing drawings	02
3.	Introduction to 3D Modeling Use of basic tools for 3D modeling (Extrude, revolve, sweep), creating basic 3D model of basic mechanical components.	04
4.	Advanced 3D Modeling -I Exploring reference planes and advanced 3D modeling tools (hole, thread slot, blend, chamfer, etc.), creating complex shapes.	02
5.	Advanced 3D Modeling -II Exploring advanced 3D modeling tools (pattern, mirror, face tool, geometry tool, etc.), creating complex shapes.	02
6.	Parametric Design Importance of parametric design, Creating parameters using formula, creating mechanical component.	02
7.	Basics of Assembly Importing components in assembly environment, applying constraints, creating simple assembly	02
8.	Advanced Assembly Techniques Basics of Top-down and bottom-up assembly techniques. Advanced mating and constraints in assemblies (use of pattern, gear and cam constraint, path constraint), creating complex assembly	02
9.	Introduction to Drafting Basics of drafting in NX CAD, Creating and annotating 2D drawings	02





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	(GD&T)	
10.	Mini Project 3D modeling, assembly and drafting (including GD&T) of mechanical assemblies.	04

References:

Text Books:

- Prof. Sham Tickoo, NX-CAD for Engineers and Designers, Dreamtech Press
- P. N. Rao, CAD/CAM principles and operations, TATA McGraw hill



Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3254	Course Name: Software Training Lab-I: MATLAB	--	--	2	1

Course Description:

Mechanical Engineers with excellent programming skills are capable to extract the realistic behavior of a system or a process. They rely on computers as a tool for programming, designing, modeling of mechanical systems and components. MATLAB programming is widely popular because of its inherent ability to handle the problems in matrix form, and its user-friendly capabilities like graphics, computations and external interface. This course covers the basic aspects of arithmetic-relational and logical operators, create, print, edit, arrays, branches and control loops, script file, etc. At the end of the course, students are expected to analyze the mechanical system behavior by writing the MATLAB code.

Course Learning Outcomes:

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

1. Write a MATLAB code and solve the mechanical engineering problems.
2. Point out the salient features and relationship between dependent and independent variables by plotting the graph.

Prerequisite:

Engineering Mathematics, Fundamentals of strength of material, design of machine components and heat transfer.

Course Content

Expt. No.	Description	Hrs.
	Introduction to MATLAB, windows in MATLAB and basic arithmetic functions.	02
1.	Creating, printing and editing simple plots in MATLAB.	02
2.	Creating and working with arrays of numbers.	02
3.	Working with matrix and array operations (arithmetic, relational, logical operations).	02
4.	Creating and executing a script file for solving mechanical engineering problem.	02
5.	Creating and executing a function file for solving mechanical engineering problem.	02
6.	Programming in MATLAB using language specific features like loops, branches and control flow for solving mechanical engineering problem.	02
7.	Application of MATLAB (Linear algebra, Curve fitting and interpolation, Data analysis, Roots of polynomials etc.).	02
8.	Introduction to any add on tool in MATLAB (e.g. GUI, Simulink).	04
9.	Intended to undertake a Mini Project which demonstrate the ability to write a code and solve mechanical engineering problems.	04



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books:

- Rudra Pratap, 'Getting Started with MATLAB', Oxford (Indian Edition)
- Partha S. Mallick, 'MATLAB AND SIMULINK: Introduction to Applications', Scitech Publications India Pvt. Ltd.

Reference Books:

- Dukipatti Rao V., MATLAB for Mechanical Engineers, New Age International Publications.
- www.mathworks.com
- www.tutorialspoint.com



Class: T. Y. B. Tech Mech	Semester: V	L	T	P	Credits
Course Code: ME3254	Course Name: Software Training Lab-I: Software Development using C++	--	--	2	1

Course Description:

Object Oriented Programming (OOP) has become the preferred programming approach by the software industries, as it offers a powerful way to cope with the complexity of real-world problems. This course teaches students to use basic concepts of OOPs, file handling and graphics programming to make them capable to develop secured program for designing mechanical components and small assembly.

Course Learning Outcomes:

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

1. Write C++ code to solve the mechanical engineering problems.
2. Use file handling operations to solve mechanical engineering problems handling large data.
3. Draw production drawing as per the design calculations.

Prerequisite:

Good understanding of C++ programming.

Course Content		
Expt. No.	Description	Hrs.
1.	Revision of OOPs with C++	02
2.	Revision of OOPs with C++	02
3.	Software development process	02
4.	Program Development for Calculation of area for aircraft wings for fixed density and for variable density	02
5.	Program development for finding the mixing of cold water in hot water for desired output temperature	02
6.	Revision of Graphics Programming	02
7.	Program on Arc & Circle drawing	02
8.	Screw Jack Design	02
9.	Screw Jack Design	02
10.	Screw Jack Design	02
11.	Screw Jack Design	02
12.	Submission	02



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books:

- E. Balguruswami, Object Oriented Programming, Tata McGraw Hill Publications.
- Yashwant Kanitkar, Let us C++, BPB Publication. Second Edition.

Reference Books:

- Herbert Schildt, The Complete Reference C++, McGraw Hill Publication.
- Robert Lafore, Object Oriented Programming in Turbo C++ ,Galgotia Publications Pvt Ltd, New Delhi.
- Bjarne Stroustrup, An Overview of C++ Programming Language, Addison Wesley Longman, Inc.
- Henricson and Erik Nyquist, Programming in C++: Rules and Recommendations, ftp-able postscript file, Ellemtel Telecommunication Systems Laboratories.





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

L	T	P	Credits
1	--	2	Audit

Course Description:

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

Course Learning Outcomes:

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

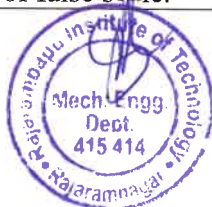
1. Develop a thorough conceptual understanding and develop a logical approach towards solving Aptitude and Reasoning problems.
2. Understand usage of basic aptitude terms like percentages, averages, ratios and applications of business aptitude terms of profits and interests
3. Develop a bridge in analogies, 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	3
2.	Percentage Understand Conversion, Single change, Successive change, Product Stability, Applications of percentage.	2
3.	Average, Allegations Weighted average, Concept of average speed & allegation, Applications of Average & mixture allegation.	2
4.	Ratio & Proportion Comparison of Ratio & fraction, Properties of Ratio & Proportion, Mean Proportion., Joint ratio	2
5.	Profit & Loss Same selling price different Cost Price, Same cost price different selling price Concept of false scale.	2



6.	Simple interest -Compound interest Basics, Difference between SI CI, Conversion Periods, Depreciation.	2
7.	TRW, Pipes & Cisterns Time, Rate and Work-Unitary Method, LCM Method, Calculation of remuneration. Pipes & Cisterns -Concept of negative work, LCM Method.	2
8.	Blood Relations Blood Relations -Symbols, generation of tree diagram, types of questions-pointing towards person, tree based, coded blood relation	2
9.	Numerical Analogy Basics, Relation between two numbers, numerical	2
10.	Pattern, Step Completion Image completion, Mirror images, Water images, input-Output	2
11.	Series Completion Types of series, Number series pattern, Letter series, Alphanumeric series	2
12.	Direction Sense Basics, shadow-based concept, Concept of local time zone (IST, GMT, Longitude, Latitude), Problems on local time difference, Coded direction sense	2
13.	Coding Decoding Letter-Letter, Letter- Number, Number-Number, Letter-Symbol, Mixed Coding	3
14.	Syllogism Basics, Types of Statements, Different diagram for different statements, Types of Questions-Based on Conclusion, Based on Statements	2

References:

Text Books:

- R. S. Aggarwal, "Quantitative Aptitude", S Chand Publishing, New Delhi.
- R. S. Aggarwal, "Logical Reasoning", S Chand Publishing, New Delhi.
- Arun Sharma, "Quantitative Aptitude", McGraw Hill Publishing, New Delhi.
- Arun Sharma, "Logical Reasoning", McGraw Hill Publishing, New Delhi.



Class: T.Y. B. Tech Mech	Semester-V
Course Code: ME3835	Course Name: Summer Internship

L	T	P	Credits
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Course Description:

At the end of third/ fourth semester, each student would undergo two 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 a Department Program Committee (DPC) to be appointed by the Director- Principal/ Principal of the college who will evaluate students.

Course Learning Outcomes:

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

1. Apply the Technical knowledge in real industrial situations.
2. Formulate Technical reports/projects.
3. Develop and refine oral and written communication skills.
4. Explain the activities and functions of business professionals.
5. Discuss knowledge of the industry in which the internship is done.

Prerequisite:

Basics of mechanical engineering, good written and oral communication

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. Meet all deadlines
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 sketches & 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 by faculty supervisor on the basis of site visit(s).
- c) 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**





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME399	Course Name: Massive Open Online Course (MOOCS)	--	--	--	1

Course Description:

Online courses offered through platforms like NPTEL, SWAYAM, and NASSCOM provide opportunities to deepen the understanding of advanced mechanical engineering concepts and technologies to Mechanical Engineering students. These courses focus on critical domains such as Design, manufacturing, thermal engineering, CAD/CAM/CAE, robotics & automation, materials engineering, and emerging fields like renewable energy and Industry 4.0. They blend theoretical foundations with practical applications, enabling students to strengthen problem-solving skills, engage with modern engineering 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 & adaptation 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 mechanical engineering.
2. Analyze mechanical engineering problems using mathematical, computational, and engineering fundamentals.
3. Design solutions for mechanical systems using modern engineering tools, software, and simulation platforms.
4. Apply programming, simulation, and analysis techniques (such as FEA, CFD, CAD/CAM) to develop and test mechanical systems and processes.
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,
 - a. 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:

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





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3104	Course Name: Finite Element Method	2	--	--	2

Course Description:

Finite element method (FEM) is a versatile and powerful analytical tool used to solve the differential equation by using approximate method. This FEM technique is quite popular in the areas of aeronautical, civil, chemical, marine, automotive, etc. The ability to handle complex geometry, boundary conditions, loading situation and material in-homogeneity is the unique characteristics of FEM approach. This course is introduced in the sixth semester with the intension to develop analytical and critical thinking skill sets. Students with sound knowledge of FEM and supplemented with thorough understanding of analysis software will enrich the capability of mechanical design engineer. FEM course aims at covering the aspects of methods to solve ordinary differential equations with approximate methods, selection of interpolation function, discretization, building element matrices, assembly and solution process.

Course Learning Outcomes:

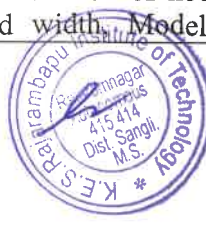
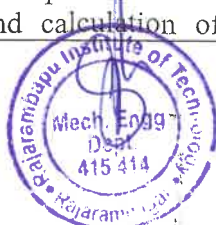
After successful completion of the course, students will be able to,

6. Applying appropriate approximate method to solve the equations from the perspective of finite element method.
7. Select the appropriate element type and element numbers to obtain accurate solutions for the given engineering problem.
8. Recommend suitable shape functions and comment on the requirement of convergence criteria.
9. Calculate the stiffness matrix, load vectors and analyse the solid mechanics problems.
10. Construct the characteristics matrix, load vectors and solve thermal related problems.
11. Explain the assembly and solution process in the finite element method.

Prerequisite:

Strength of material, Design of machine components, Heat transfer.

Course Content		
Unit No	Description	Hrs.
1.	Overview of Finite Element Method Brief history, Steps in FEM, Structural analysis of stepped bar, Principle of minimum potential energy, Approximate method to solve the differential equation using Rayleigh Ritz method, Galerkin method and Least square method.	04
2.	Discretization Introduction, Geometrical approximations, Simplification through symmetry, Basic element shapes and behavior, Choice of element type, size and number of elements, Elements shapes and distortion, Location of nodes, Node and element numbering and calculation of band width, Model validity and	03



	accuracy, Mesh design and refinement.	
3.	Interpolation Function Simplex, Complex and Multiplex element, Linear interpolation polynomial for simplex element, Convergence requirement, Natural co-ordinates, Deriving shape functions for simplex and complex element (Only 1D and 2D elements).	03
4.	Formulation of elements characteristic matrices and load vectors for elasticity problem Introduction to one dimensional (1D) and two-dimensional structural elements (2D), calculation of load vectors, stiffness matrix for 1D and 2D simplex element only. Introduction to numerical integration.	05
5.	Formulation of elements characteristic matrices and load vectors for thermal problem One-dimensional and two-dimensional thermal elements and fluid flow, calculation of load vectors, characteristics matrix for 1D and 2D element only.	05
6.	Assembly and solution process Co-ordinate transformation, assembly of elemental equation, Incorporation of boundary conditions, Elimination method, Penalty method, Mult constraint.	04

References:

Text Books:

- M.J. Fagan, Finite Element Theory and Practice, Longman Scientific Technical Publisher.
- P. Seshu, Finite Element Analysis, PHI.
- S.S. Rao, Finite Element Method In Engineering, Elsevier.

Reference Books:

- Robert D. Cook, Concept and Application of Finite Element Analysis, John Willey and Sons.
- J N Reddy, An Introduction to Finite Element Method, Tata MacGraw Hill Publisher.
- Chandrapatala and Belagunda, Introduction to Finite Element in Engineering, PHI.



Class: T. Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3124	Course Name: Applied Thermal Engineering	3	--	--	3

Course Description:

Mechanical engineering deals with conversion of one form of energy in to other useful form. Conversion of Fluid energy in to Mech. energy & mechanical energy in to fluid energy plays important role, which is the scope of this course. Study of these machines, selection of these machines for particular applications is content of syllabus.

Course Learning Outcomes:

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

1. Differentiate SI and CI engine, cycles, and relate various performance parameters.
2. Analyze the performance of vapour compression refrigeration systems.
3. Estimate the performance of steam boilers.
4. Design a steam nozzle for given condition and calculate nozzle efficiency.
5. Compute efficiency and power developed by impulse and reaction turbines.
6. Calculate vacuum, condenser efficiency, cooling water required for condensing and compare environmental pollution norms.

Prerequisite:

Students should know Concept of energy, work, heat and conversion between them. Engineering thermodynamics, fluid mechanics.

Course Content		
Unit No.	Description	Hrs
1.	I C Engines Introduction, Classification of I. C. Engines, Basic engine components and nomenclature, applications, two stroke and four stroke engine, performance parameters, performance and testing of I C Engines, Heat balance sheet (numerical treatment) emissions in SI & CI engines.	06
2.	Refrigeration Cycles & Refrigerants Refrigeration cycles: Reversed Carnot cycle for refrigeration and heat pump, simple Vapour Compression Cycle (VCC), effect of operating conditions. (Numerical) Refrigerants: Classification, properties of refrigerants, designation of refrigerants.	06
3.	Steam Boiler Steam power plant layout, Rankine cycle, Classification of boilers, Boiler parts and functions, water tube and fire tube boiler, boiler mountings and accessories, Performance evaluation of boilers, equivalent evaporation, factor of evaporation, boiler efficiency, economizer efficiency, overall efficiency, boiler power etc. (Numerical Treatment)	06
4.	Steam Nozzle Functions, shapes, critical pressure ratio, maximum discharge condition, effect of friction, design of throat and exit areas, nozzle efficiency, velocity	06

	coefficient, coefficient of discharge (Numerical Treatment)	
5.	Steam Turbines Principles of operation, classification, impulse and reaction steam turbine, compounding of steam turbines. Flow through impulse turbine blades, velocity diagrams, work done, efficiencies, end thrust, blade friction, influence of ratio of blade speed to steam speed on efficiency of single stage turbine. Flow through impulse reaction blades, velocity diagrams and degree of reaction, parson's reaction turbine. (Numerical Treatment)	06
6.	Steam Condensers Functions, elements of condensing plant, types of steam condensers, surface and jet condensers, comparison, vacuum efficiency, condenser efficiency, loss of vacuum, sources of air leakages, methods of leak detection, air extraction methods, estimation of cooling water required, capacity of air extraction pump, air ejectors. (Numerical Treatment), types of cooling tower, standard pollution norms like EURO, BS, GWP, ODP, etc.	06

References:

Text Books: -

- V. Ganeshan, Internal Combustion Engines, Mc Graw Hill
- M. L. Mathur, R. P. Sharma, Internal Combustion Engine, 8, Dhanpat Rai Publications
- Arora Domkundwar, Refrigeration and Air Conditioning, Dhanpatrai and sons Publications.
- R. S. Khurmi, Refrigeration and Air Conditioning, S. Chand Publications.
- R. K. Rajput, Thermal Engineering, Laxmi Publications, Delhi
- R. Yadav, Steam & Gas Turbines, CPH Allahabad.
- B. K. Sarkar, Thermal Engineering, Tata McGraw Hill.

Reference Books: -

- V.P. Vasandani, Hydraulic Machines, Khanna Publishers
- N.S. Govindrao, Fluid flow machines, Tata McGraw Hill.
- S.M. Yahya, Turbo machines, Satya Prakashan, Delhi.
- P.L. Balleny, Thermal Eng. , Khanna Publishers, Delhi.
- Modi and Seth, Fluid Mechanics and Hydraulic Machines, Standard Book House, Delhi.
- Mahesh M. Rathore, Thermal Engineering, McGraw Hill.

Data Book:

- S. C. Jain, Steam Tables, Birla Publications Pvt. Ltd. Delhi.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech Mech	Semester: VI
Course Code: ME378	Course Name: Machine Design

L	T	P	Credits
3	--	--	3

Course Description:

This course covers the design of machine components under fluctuating and dynamic loads with a focus on fatigue analysis. It introduces gear design fundamentals, including spur, helical, bevel, and worm gears, along with manufacturing and assembly considerations. The course also explores bearing selection and design, emphasizing rolling and sliding contact bearings. Students will apply analytical techniques and design standards to ensure safe and efficient mechanical system performance.

Course Learning Outcomes:

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

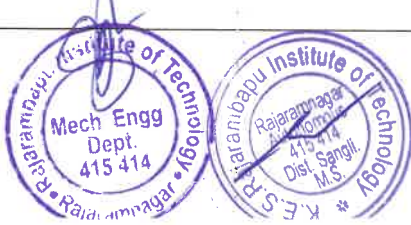
1. Design components for fatigue using S-N curves, endurance limits, and failure theories.
2. Design spur and helical gears using force analysis and strength equations.
3. Evaluate bevel and worm gears for strength, safety, and thermal performance.
4. Apply DFMA principles for casting, forging, machining, and assembly.
5. Select rolling bearings based on load, life, and failure analysis.
6. Analyze lubrication and design aspects of hydrodynamic bearings.

Prerequisite:

Strength of Material, Mechanical Component Design and Machine Design.

Course Content

Unit No	Description	Hrs
1.	Design against Fluctuating load Stress concentration - causes & remedies, fluctuating stresses, S-N diagram under fatigue load, endurance limit, notch sensitivity, endurance strength-modifying factors, design for finite and infinite life under reversed stresses, cumulative damage in fatigue failure, Soderberg and Goodman diagrams, modified Goodman diagram, fatigue design for components under combined stresses such as shafts, and springs. High cycle and low cycle fatigue, cumulative damage theories.	06
2.	Design of Gears Drive-I Classification of gears, desirable properties and selection of gear materials, standard gear tooth systems. Modes of gear tooth failures, methods of lubrication. Spur gear: Number of teeth and face width, construction details of gear wheel, force analysis, Beam strength (Lewis) equation, velocity factor, service factor, load correction factor, effective load on gear. Wear strength (Buckingham's) equation, estimation of module based on beam and wear strength. Estimation of dynamic tooth load by velocity factor and Buckingham's equation. Helical Gear:	06



	Types, Terminology, Formative number of teeth in helical gears, force analysis, Beam & wear strength of helical gears, Effective load & design of helical gear.	
3. Design of Gears Drive-II	Bevel gear: Terminology, materials for bevel gear, Formative number of teeth, force analysis, Beam & wear strength, Effective load on straight bevel gear, Safety of bevel gear, mounting of bevel gear Worm Gear: Terminology, Designation of worm gears, force analysis, Types of failures in worm gear, Beam & wear strength of worm gear tooth, Thermal considerations in worm gear drive.	06
4. Design for Manufacture and Assembly	Concurrent engineering, Designing for manufacture (DFM), Design for casting, Design for forging, Design for machining, Design for Welding, Design for Assembly, Case studies.	06
5. Rolling Contact Bearings	Types of rolling contact bearings, Designation, static and dynamic load carrying capacities, Stribeck's equation, Equivalent bearing load, load life relationship, selection of bearing life, Selection of rolling contact bearings from manufacturers catalogue, design for cyclic loads and speed, bearing with probability of survival other than 90%, lubrication and mounting of bearings, Preloading of rolling contact bearings, Types of failure in rolling contact bearing - causes and remedies.	06
6. Sliding Contact Bearings	Basic modes of Lubrication, physical and chemical properties of lubricant, Desirable properties of lubricant, Classification of lubricant. Bearing material and their properties: Sintered bearing materials, bearing types and their construction details. Hydro-dynamic bearing Basic theory, thick and thin film lubrication, Reynolds's equation, Sommerfeld Number. Design consideration in hydrodynamic bearings, Raimondi and Boyd method relating bearing variables. Heat balance - Design aspects, Temperature rise, Introduction to hydro-static bearing.	06

References:

Text Books:

- V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication.
- S. P. Patil, Mechanical System Design, Jaico Publication House, New Delhi.
- S. K. Basu and D. K. Pal, Design of Machine Tools, Oxford and IBH Publication.
- N. K. Mehta, Machine Tool Design, Tata McGraw Hill Publication.

Reference Books:

- Shigley and C. R. Mischke, Mechanical Engineering Design, Tata McGraw Hill Publication.
- R. L. Norton, Machine Design – An Integrated Approach, Pearson Education.
- Juvinall R. C. and Marshek K. M., Fundamentals of Machine Component





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Design, Wiley India.

- Spotts M. F., Shoup T. E., Design of Machine Elements, Pearson Education.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME316	Course Name: Research Methodology	2	--	--	2

Course Description:

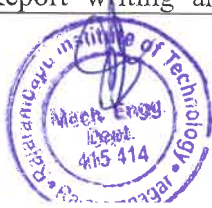
This course is designed to help students develop the research skills required to competently undertake and complete research projects. It will provide students with the training required to develop the skills to review and critically analyze literature on topics related to their research projects, justify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

Course Learning Outcomes:

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

1. Select, analyse and interpret research evidences published on a topic to establish a suitable research problem/issue or opportunity to explore further.
2. Design the research study using a suitable paradigm, associated methodologies and methods of data collection and analysis.
3. Write a research proposal (research blueprint) describing the topic.
4. Demonstrate the ability to use statistical software to solve problems.

Course Content		
Unit No	Description	Hrs
1.	Basics of research Definition of research and characteristics of research; Types of research. Hypothesis - Qualities of a good Hypothesis- Null Hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & Importance.	04
2.	Literature Review Importance of literature review, types of literature review, selection of the review topic, searching for the literature, analyzing, and synthesizing the literature, writing the review report.	04
3.	Design of experiments and Data Analysis Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs-concept, types and uses. Analysis of variance, Regression analysis, Response surface methods for process optimization, SPSS/MINITAB software.	04
4.	Sampling Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling.	04
5.	Interpretation of Data and Paper/Report Writing Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, Report writing and Plagiarism. Ethical issues related to	04



	publishing,	
6.	Intellectual Property Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents; their definition; granting; infringement; searching & filing; Utility Models an introduction; Copyrights; their definition; granting; infringement; searching & filing, Trademarks, role in commerce, importance, protection, registration; domain names; Department specific research discussions	04

References:

Textbooks:

- Kothari C.K, Research Methodology – Methods and Techniques (New Age International, New Delhi).

Reference Books:

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





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T.Y. B. Tech Mech.	Semester: VI
Course Code: ME322	Course Name: Industrial Robotics

L	T	P	Credits
3	--	--	3

Course Description:

This course is designed to provide undergraduate students with a comprehensive understanding of industrial robotics, focusing on advanced concepts and applications. The course covers fundamental principles, programming techniques, sensors, actuators, and industrial automation.

Course Learning Outcomes:

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

1. Explain the fundamental concepts of robots.
2. Model forward and inverse kinematics of robot manipulators.
3. Select end effector and sensor for particular application
4. Write a program for a robot to perform tasks in industrial applications.

Prerequisite: Kinematics of mechanism

Course Content		
Unit No	Description	Hrs.
1.	Fundamentals of Robotics History of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, laws of robotics, Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Precision of Movement: Resolution, accuracy and precision of Robot, dexterity, compliance, RCC device, Work cell control, Speed of Response and Load Carrying Capacity	06
2.	End Effectors and Sensors for Robotics END EFFECTORS: Grippers, Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Internal Grippers and External Grippers; Advance Grippers- Adaptive grippers, Soft Robotics Grippers, Tactile Sensor Grippers; Various process tools as end effectors; Active and passive compliance, Selection and Design Consideration. SENSORS: Internal state sensors, external state sensors, Encoder, optical Position sensors, velocity sensors, proximity sensors, touch and slip sensors, force and torque sensors, Selection considerations	06
3.	Motion Analysis Link Equations and relationships, Direct Kinematics, Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Composite Rotation matrix, Homogenous Transformations, Joint Co-ordinate and world co-ordinate System, inverse kinematics of two joints, DH Parameters, Jacobian Transformation in Robotic Manipulation	06



4.	Trajectory and Motion Planning Introduction, Linear trajectory function, polynomial trajectory function, Gross and fine motion planning, motion planning schemes-visibility graph, vornoi diagram, tangent graph, accessibility graph, path velocity decomposition, incremental planning, relative velocity approach, reactive control strategy and potential field approach.	06
5.	Robot Programming Introduction to Robotic Programming, On-line and off-line programming, programming examples. Various Teaching Methods, Survey of Robot Level Programming Languages, A Robot Program as a Path in Space, Motion Interpolation, Programming Languages: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., sample Program Examples a robot-based manufacturing system	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, Machine vision in robot for object picking Robot Intelligence and Task Planning, Modern Robots, cobots, Application of machine vision in robotics. Robot applications in medical industries.	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 318 NIT Rourkela India, New Delhi.
- Mikell P Groover, Industrial Robotics - Technology, Programming and Applications, McGraw Hill
- Introduction to Robotics- John J. Craig, Addison Wesley Publishing,

Reference Books:

- James A Rehg, Introduction to Robotics in CIM Systems, Prentice Hall of India
- Deb S R, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi
- Janaki Raman P A, Robotics and Image Processing, Tata McGraw Hill
- Robotics for Engineers –Yoram Koreh, McGraw Hill International.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Program Elective-II

Class: T. Y. B. Tech Mech	Semester: VI
Course Code: ME3264	Course Name: Machine Tool Design

L	T	P	Credits
3	--	--	3

Course Description:

This course aims to prepare students for developing their careers in design engineering especially in Machine Tool Design. The course will impart students the capability to design machine tools by understanding functional and operational requirements. This course will provide thorough understanding and application of the concepts of design of machine tools, design and/or selection of drives for machine tools; will impart knowledge to design machine tool structures, Design of beds, columns and housings, all types of guide ways, power screws, spindle, spindle supports and other parts of machine tools. It will also impart the knowledge of the dynamics of machine Tools and select the proper control system.

Course Learning Outcomes:

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

1. Select & design drive system for machine tool.
2. Decide layout of machine tool.
3. Design machine tool structure, guide ways and power screws.
4. Determine dynamic characteristics of machine tool & carry stability analysis.
5. Demonstrate control systems in machine tools and SPM.

Prerequisite:

Students should have,

1. A good understanding of different types of drives and their selection.
2. Strong understanding of Analysis of mechanical elements, strength of materials and mechanical component design.

Course Content

Unit No	Description	Hrs.
1.	Design of Machine Tool Drives General requirements of machine tool design, Layout of machine tools, Working and auxiliary motions in machine tools. Selection of Electric Motor, Types of Speed and feed regulation, Classification of speed and feed boxes, Design of feedbox, Speed box, Development of gearing diagram, Stepless Drives: Stepless Regulation of Speed & Feed Rates through Hydraulic, Electric & Mechanical means, Positively Infinitely Variable Drive.	06
2.	Design of Machine Tool Structure Functional requirements of machine tool structures, Design criteria & procedure for machine tool structures, Materials for machine tool structures, Design of beds, columns, housings, and other parts of machine tools. Design Case Studies of a) Bed of Lathe, b) Column & Base of Milling Machine, c) Housing of Speed Gearbox	06



3.	Design of Guide ways and Power Screws Function & Types of Guideways, Types of Slideways & Antifriction Ways, Functional features of Slideways, its Shapes & Materials, Methods of adjusting Clearance, Design Criteria (Wear Resistance & Stiffness) and Calculations for Sideways, operating under semi liquid friction condition, 'Stick Slip' phenomena affect accuracy of setting & working motions. Design of sliding friction Power Screw for Wear Resistance, Strength, Stiffness & Buckling Stability.	06
4.	Design of Spindle and Spindle Supports Function & Requirements of Spindle Units, their Materials, Effect of Machine Tool Compliance on Machining accuracy Design of Spindle for Bending Stiffness: Deflection of Spindle Axis due to a) Bending, b)-due to Compliance of Spindle Supports, c)-due to Compliance of the Tapered Joint; Optimum Spacing between Spindle Supports Permissible Deflection & Design for stiffness: Additional Check for Strength like Additional Supports, Location of Bearings and Drive elements, balancing, Requirements of Spindle Supports, Bearings for spindles.	06
5.	Dynamics of Machine Tools Machine Tool Elastic System-cutting Process Closed-loop System, General Procedure for Assessing Dynamic Stability of EES—Cutting Process Closed-Loop System, Dynamic Characteristics of Elements and Systems, Dynamic Characteristic of the Cutting Process, Stability Analysis, Forced Vibrations of Machine Tools.	06
6.	Control Systems in Machine Tools Functions, requirements and classification, Control systems for speeds, feeds and various motions, Manual & automatic control systems, adoptive control systems Numerical Control of machine tools- fundamental concept, classification and structure of NC system, CNC, DNC Machining Centers	06

References:

Textbook:

- N. K. Mehta, Machine tool design and numerical control, Tata McGraw Hill Publication.

Reference Books:

- S. K. Basu, Design of Machine Tools, Oxford and IBH publishing, New Delhi
- P. H. Joshi, Machine tools handbook-Design and operation, McGraw Hill, New Delhi
- Sen and Bhattacharya, Principles of machine Tools, New age central book agency
- Koenigs-Berger, Principles of machine Tools, Oxford, New York, Pergamon Press
- T H Wentzell, Machine Design Cengage Learning, New Delhi.
- G. K. Grover, Mechanical Vibration, Nemchand & Brothers, Roorkee.
- Dr. V. P. Singh, Mechanical Vibration, S. Chand & Sons New Delhi.
- N/A Central Machine Tool Institute, Machine Tool Design Handbook Hardcover





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Rajarambapu Institute of Technology, Rajaramnagar
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 Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering
Program Elective-II

Class: T.Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME328	Course Name: Smart Material and Systems	3	--	--	3

Course Description:

Smart materials and systems is an emerging area with numerous potential applications in industries as diverse as consumer, sporting, medical and dental, computer, telecommunications, manufacturing, automotive, aerospace, as well as civil and structural engineering. The course introduces the student to the basic principles and mechanisms of smart materials and devices. The course deals with details of design, modelling and fabrication of smart systems. Also, the course is designed to give an insight into the latest developments regarding smart materials and their use in mechanical systems.

Course Learning Outcomes:

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

1. Describe the behaviour and applicability of various smart materials.
2. Demonstrate the design methods of smart sensors and actuators.
3. Model smart sensors and actuators for specific application.
4. Demonstrate the techniques of fabrication of smart systems.
5. Design simple smart system for specific application.

Prerequisite:

Knowledge of Engineering physics, Mechanics of Materials and Metallurgy

Course Content

Unit No	Description	Hrs.
1.	Overview of Smart Systems Evaluation of Smart Materials and systems, Smart system and its components, active and passive smartness, Processing of Smart Materials: Semiconductors and their processing, Metals and metallization techniques, Ceramics, Silicon micromachining techniques, UV radiation curing of polymers, Deposition techniques for polymer thin films, Properties and synthesis of carbon nanotubes	06
2.	Smart Solids and Fluids Piezoelectric Materials: Piezoelectric effect and materials, Properties of piezoelectric material, Mathematical description of piezoelectric effect, PVDF, Shape Memory Alloys (SMA): Phenomenology of phase transformation, Shape memory effects, Pseudoelasticity, Effect of alloying on the transformation behavior of SMAs, Characterization of SMAs, Magneto-rheological Elastomer(MRE), Electro-rheological(ER) and Magneto-rheological fluids Magnetostrictive, Self – healing materials, materials, Fiber Optics.	06
3.	Design principles of Sensors and Actuators Sensors: Piezoelectric, Magnetostrictive, Optical Resonant, Semiconductor-based, Acoustic, Polymeric and Carbon nanotube sensors, Actuators:	06



	Electrostatic, Electromagnetic, Electrodynamic, Piezoelectric, Electrostrictive, Magnetostrictive actuators, Design Examples for Sensors and Actuators.	
4.	Modeling of Smart Sensors and Actuators Modeling of a 3-D composite laminate with embedded piezoelectric sensors and actuators, Modeling of magnetostrictive sensors and actuators, Modeling of micro electromechanical systems, Modeling of carbon nanotubes (CNTs)	06
5.	Fabrication Methods for Smart Systems Silicon Fabrication Techniques for MEMS: Fabrication processes for silicon MEMS, Deposition techniques for thin films, Bulk micromachining for silicon-based MEMS, Silicon surface micromachining, Processing by both bulk and surface micromachining, Polymeric MEMS Fabrication Techniques, Fabrication Examples of Smart Microsystems.	06
6.	Applications of Smart Materials and Systems Structural health monitoring: Monitoring of composite wing-type structures using magnetostrictive sensors/actuators, Assessment of damage severity and health monitoring using PZT sensors/actuators, Wireless MEMS-IDT microsensors for health monitoring of structures, Vibration and Noise-Control Applications, Applications in the field of aerospace and medical, Futuristic Applications of Smart Materials.	06

References:

Text Books:

- Vijay k. Varadan, K.J. Vinoy, S. Gopalkrishana, "Smart Materials Systems and MEMS: Design and Development Methodologies" John Wiley and Sons.
- B. Culshaw, "Smart Structures and Materials", Artech House, Boston.

Reference Books:

- M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman & Hall, London; New York,
- Dimitris C. Lagoudas, "Shape Memory Alloys: Modelling and Engineering Applications" Springer Publication.
- Chee -Kiong Soh, Yaowen Yang, Suresh Bhalla, "Smart materials in Structural Health Monitoring, Control and Biomechanics", Zhejiyang University Press, Springer Publication.
- Mel Schwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
- H. Janocha, "Actuators - Basics and Applications", Springer Publication
- A. V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press, Cambridge; New York.
- G. Gautschi, "Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers", Springer, Berlin; New York
- K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston
- G. Engdahl, "Handbook of Giant Magnetostrictive Materials", Academic Press, San Diego, Calif.; London.
- K. Otsuka and CM. Wayman, "Shape Memory Materials", Cambridge University Press.





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Rajarambapu Institute of Technology, Rajaramnagar
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To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3304	Course Name: Engineering Acoustics	3	--	--	3

Course Description:

Engineering Acoustics is an exciting area offering multidisciplinary studies of sound and vibration phenomena. It relates to recorded music, to speech and hearing, to the behavior of sound in concert halls and buildings, and to noise in our environment. Sound waves are used in medical diagnosis, for testing critical materials, and for locating fish in the ocean or oil-bearing rock formations underground. The rapidly developing research in this area includes theoretical, numerical and experimental aspects. Engineering Acoustics aims to provide the conceptual framework and research training required for advanced professional work in the fields of: Human hearing science & audiology, Transducer technology and systems, Sound recording and reproduction, Acoustic design of rooms & auditoria, Outdoor sound & noise abatement, Noise control in buildings, Vibration and noise control in vehicles and machinery.

Course Learning Outcomes:

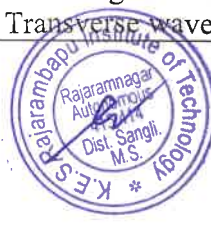
After successful completion of the course, students will be able to,

1. Determine acoustic parameters of sound waves in decibel levels for pressure, power and intensity.
2. Calculate sound levels 1-D wave for air-borne sound.
3. Estimate absorption coefficient for different acoustic materials.
4. Measure sound levels of any systems/product and reduce it up to audible range by using suitable method.

Prerequisite:

Knowledge of Physics, Complex Variables, Engineering Mathematics and Vibration.

Course Content		
Unit No	Description	Hrs
1.	Fundamentals of Sound The Simple Sinusoid, Wavelength, Frequency, Speed of Sound, Complex Waves - Harmonics, Phase, Partial, Octaves, The concept of spectrum, Sound Levels and the Decibel - Ratios vs. Differences, Handling numbers, Logarithms, Decibels, Reference Levels, Logarithmic and Exponential Forms Compared, Acoustic Power, Ratios and Octaves. Sound fields, Loudness vs. Frequency.	06
2.	The Wave Equations and Solutions Derivation of the wave equation, the wave equation in rectangular co-ordinates, the wave equation in spherical co-ordinates. Solutions of the wave equation-General solution of the one-dimensional wave equation, Steady-state solution, Freely Travelling plane wave, freely travelling spherical wave.	06
3.	Structure-Borne Sound Introduction. Longitudinal waves-Pure Longitudinal wave, Quasi-Longitudinal waves on Beams and Plates. Transverse waves-Transverse Plane	06



	waves, Torsional waves. Bending Waves-Pure Bending waves, Energy relations.	
4. Acoustic Transducers	Micrphones-technical considerations, The carbon granule microphone, condenser microphone, electrets capacitor microphone, electrodynamic/moving coil microphone, piezoelectric microphone, The ribbon microphone. Acoustic exciters-electrostatic loudspeaker, electrodynamic loudspeaker, electropneumatic transducer. Acoustic calibrators.	06
5. Acoustical Materials	Absorbing materials, Barrier materials. Room acoustics- Average absorption coefficient, Room constant, Sound pressure and sound power relations, atmospheric attenuation, implications of opening. Enclosure Design- Design for maintenance, inspection and ventilation.	06
6. Noise Measurement and Case Studies	Sound intensity measurement on helicopter, sound measurement on internal combustion engine, gearbox, centrifugal pump, reciprocating compressor and steam turbine.	06

References:

Text Books:

- Leo L. Bernack, Noise and Vibration Control, Tata McGraw Hill, New Delhi.
- A.G. Ambekar, Mechanical Vibration and Noise Engineering, Prentice Hall of India
- C. Sujatha, Vibration and Acoustics, Tata McGraw Hill, New Delhi.

Reference Books:

- Leo L. Beranek, Acoustics, Acoustical Society of America.
- F. Alton Everest, The master Handbook of Acoustics, Tata McGraw Hill, New Delhi.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T.Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3364	Course Name: Energy Conservation & Management	3	–	–	3

Course Description:

This course summarizes the energy scenario and need of energy conservation, This course intentionally focusses on waste heat recovery techniques and energy auditing, Explain the various measures for energy conservation and financial implications for various thermal utilities.

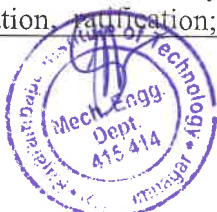
Course Learning Outcomes: At the end of the course the students will be able to

1. Summarize energy scenario and the need for energy conservation.
2. Conduct energy audit of a system
3. Illustrate various techniques of waste heat recovery and cogeneration.
4. Identify energy conservation measures in various thermal utilities.
5. Summarize different financial terms and techniques used in Energy Conservation.

Prerequisite:

Engineering Thermodynamics, Fluid mechanics

Course Content		
Unit No	Description	Hrs
1.	Energy Scenario Primary and Secondary Energy, Conventional and nonconventional energy, Energy Security, Energy Conservation and its importance, Energy conservation Act., Thermal Energy basics, Need of energy Audit and management, Global warming.	6
2.	Energy Audit & Instruments for Energy Auditing Energy Audit its definition & methodology, Energy Audit Instruments, Benchmarking for energy performance, Energy Action Planning, Duties and responsibilities of Energy Manager, Energy financial management, Project Management, Energy monitoring and targeting, pinch technology. Detailed energy audit Methodology, Standard guide for conducting energy audit, plant visit for preparation of energy audit phase I and Phase II considering a case study, Instrument characteristics – sensitivity, readability, accuracy, precision, hysteresis. Error and calibration. Measurement of flow, velocity, pressure, Temperature, Speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality.	6
3.	Material & Energy balance with Waste Heat Recovery Material & Energy balance, Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams. Cogeneration and waste heat recovery.	6
4.	Energy Action Planning Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of	6



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

	energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system-designing barriers, strategies; Marketing and communicating: Training and planning. Monitoring and targeting.	
5.	Thermal Utilities: Operation and Energy Conservation Boilers, Thermic Fluid Heaters, Furnaces, Refrigeration Systems, Thermal Storage, Fans and Blowers, Electrical system, lighting, motors.	6
6.	Financial Management Investment – need, appraisal and criteria, financial analysis techniques – break even analysis – simple payback period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.	6

References:

Text Books:

- Smith, CB Energy Management Principles, Pergamon Press, New York.
- Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington.
- Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi.
- Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington.
- Diamant, RME, Total Energy, Pergamon, Oxford.

Reference Books:

- Handbook on Energy Efficiency, TERI, New Delhi.
- Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com).
- Handbook of Energy Engineering Albert Treemann & Paul Mehta The Fiarmout Press Inc
- G. L. Witte, Phillips S.Schmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washingto.
- Carig,B. Saith, Energy Management Principles, Applications, Bnefit and Saving, Pern Press, New York.





K.E. Society's
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3384	Course Name: Gas Turbine & Jet Propulsion	3	--	--	3

Course Description:

The course is intended to explore the basics of fluid dynamics applied to jet propulsion, gas turbine, turbojet and turbofan engines, compressor, and combustor. It also gives background in combustion, one-dimensional compressible internal flows, and the thermodynamics of Brayton-cycle engines.

Course Learning Outcomes:

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

1. Compare ideal and real cycles of gas turbines
2. Illustrate different techniques used in jet propulsion
3. Explain centrifugal compressor used in gas turbines and jet propulsion
4. Design axial flow compressor used in gas turbines and jet propulsion
5. Analyze combustion system of the gas turbines
6. Evaluate the different turbines used in gas turbine and jet propulsion

Prerequisite:

Thermodynamics, Heat Transfer, Fluid Mechanics.

Course Content		
Unit No	Description	Hrs.
1.	Ideal and real cycles of gas turbines Classification of Turbomachines, Applications of Gas Turbines, Assumptions for Air-Standard Cycles, Simple Brayton Cycle, Heat Exchange Cycle, Inter-cooling and Reheating Cycle, Comparison of Various Cycles. Methods of Accounting for Component Losses, Isentropic and Polytropic Efficiencies, Transmission and Combustion Efficiencies, Comparative Performance of Practical Cycles, Combined Cycles and Cogeneration Schemes. Numericals	06
2.	Jet Propulsion Cycles and their Analysis Criteria of Performance, Simple Turbojet Engine, Simple Turbofan Engine, Simple Turboprop Engine, Turbo-shaft Engine, ramjet Thrust Augmentation Techniques. Thrust and force –Numericals	06
3.	Centrifugal Compressors Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio, The Diffuser, The Compressibility Effects, Pre-rotation and Slip Factor, Surging and Choking, Performance Characteristics.	06
4.	Axial Flow Compressors Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio, Degree of Reaction,	06



	Work done factor, Three-Dimensional Flow, Design Process, Blade Design, Stage Performance, Compressibility Effects	
5.	Combustion System Operational Requirements, Classification of Combustion Chambers, Factors Effecting Combustion Chamber Design, The Combustion Process, Flame Stabilization, Combustion Chamber Performance, Some Practical Problems Gas Turbine Emissions.	06
6.	Axial and Radial Flow Turbines Construction and Operation, Vortex Theory, Estimation of Stage Performance, Overall Turbine Performance, Turbine Blade Cooling, The Radial Flow Turbine. Off-Design Performance of Single Shaft Gas Turbine, Free Turbine Engine, Jet Engine, Methods of Displacing the Equilibrium Running Line.	06

References:

Text Books:

- Ganesan V., Gas Turbines, Tata McGraw Hill.

Reference Books:

- Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., Gas Turbine Theory, Pearson Prentice Hall
- Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, Elsevier
- Flack, R.D., Fundamentals of Jet Propulsion with Applications, Cambridge University Press
- Yahya, S. M., Turbines, Compressors and Fans, Tata McGraw Hill
- Lefebvre, A.H., Gas Turbine Combustion, CRC Press,
- M. L. Mathur and R.P. Sharma, GAS TURBINES AND JET AND ROCKET Propulsion, Nern Chand Jaitl (Prop.), Standard Publishers Distributors
- Meherwan P. Boyce, Gas Turbine Engineering Handbook, Gulf Professional Publishing



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME340	Course Name: Computational Fluid Dynamics (CFD)	3	--	--	3

Course Description:

An introduction to computational fluid dynamics (CFD) in Mechanical Engineering gain knowledge of use of modern CFD software to build, solve, and visualize fluid-flow models. The course is aimed to give a basic understanding to the discretization of equations of mass, momentum and energy. The course covers numerical methods for physical simulations of gas and liquid flows. The course is based on the finite difference method and the finite volume method with emphasis on fluid dynamics and includes various computational problems in fluid dynamics such as boundary conditions and meshing.

Course Outcomes:

At the end of the course the student will be able to

1. Derive governing equations for fluid dynamics and heat transfer.
2. Develop finite difference implicit & explicit algorithms for fluid flow and heat transfer problems.
3. Develop finite volume algorithms for fluid dynamics equations.
4. Select appropriate grid generation methods for CFD analysis.
5. Apply different CFD Techniques to various fluid flow problems

Pre-Requisites:

Fluid mechanics, Heat transfer, Numerical methods.

Course Content		
Unit No.	Description	Hrs.
1.	Conservation laws of fluid dynamics and heat transfer Models of fluid flow, substantial derivative, divergence of velocity, conservative and nonconservative forms of continuity, momentum and energy equations. Integral and differential analysis, physical boundary conditions	06
2.	Aspects of discretization Mathematical behavior of partial differential equations, Classification of Elliptic hyperbolic and parabolic equations. Finite difference approximation, difference equations. Implicit and explicit approximation, Time marching, Space marching, Error and stability analysis.	06
3.	CFD techniques Geometry discretization, Euler's FTBS, FTCS and FTBCS, Dufort-Frankel Method, Lax-Wandroff technique, Macormac's technique, Relaxation technique, ADI technique, pressure correction technique.	06
4.	Finite volume method FVM for Steady state diffusion, convection diffusion problems, tridiagonal matrix algorithm. Finite volume method for two-dimensional diffusion problems, Properties of discretization schemes, Transient problems with QUICK, SIMPLE schemes	06



5.	Grid with transformation General transformation equation, metrics and Jacobian, stretched, elliptic and adaptive grids. Unstructured grid structure, stream function-vorticity transformation, parabolic and hyperbolic grid generation	06
6.	Advanced CFD Algorithms Co-ordinate transformation, Shock capturing, Pressure - velocity coupling in steady flows: Staggered grid, SIMPLE algorithm, SIMPLER, SIMPLEC algorithms, Worked examples of the above algorithms, cell centered scheme, nodal point scheme.	06

References:

Text Books:

- Computational Fluid Dynamics, J. D. Anderson, The Basics with Applications, McGraw Hill.
- Computational Fluid Flow and Heat Transfer, K. Muralidhar and T. Sundararajan, Narosa Publishing House.
- Numerical Heat Transfer and Fluid Flow, S. V. Patankar, Taylor and Francis (Indian Edition).
- Introduction to Computational Fluid Dynamics, A. W. Date, Cambridge (Indian Edition).

Reference Books:

- Computational Fluid Dynamics for Engineers - Volume 1, K. A. Ho_mann, S. T. Chiang, Engineering Education System.
- Essential Computational Fluid Dynamics, O. Zikanov, Wiley India.
- An Introduction to Computational Fluid Dynamics, Versteeg, H. K. and Malalasekera, W.
- The Finite Volume Method, Pearson.
- Computational Fluid Dynamics: A Practical Approach, J. Tu, G. H. Yeoh and C. Liu, Butterworth Heinemann (Indian Edition).





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Curriculum Structure and Evaluation Scheme
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Department of Mechanical Engineering
Program Elective-II

Class: T.Y. B. Tech Mech.	Semester: VI
Course Code: ME3424	Course Name: Alternative Fuels

L	T	P	Credits
3	--	--	3

Course Description:

In this course, students will learn about various sources of alternative fuels used in the alternative-fueled vehicle. The course will also cover the need for alternative fuels, including LPG, Natural Gas, Ethanol, Biodiesel etc. Students will also learn about new technologies such as Electric, hybrid Drive, and Hydrogen fueled vehicles, as well as Fuel Economy considerations.

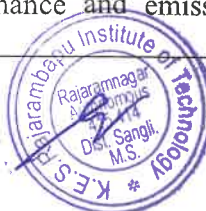
Course Learning Outcomes:

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

1. Justify the need of alternative fuels for IC engines.
2. Select alternative fuels to IC engines
3. Analyze engine performance using blended fuels
4. Explain the working of electrical and solar-powered vehicles.

Prerequisite: Basics of IC Engine

Course Content		
Unit No	Description	Hrs
1.	Engines Working processes in I.C. engine, fuel efficiency, fuel requirement, ignition quality, volatility, sources of fossil fuels, the scope of availability of fossil fuels, need for alternative fuels, engine life.	06
2.	Alcohols Sources, methanol and ethanol, production methods, properties of methanol and ethanol as engine fuels, Use of alcohols in S.I. and C.I. engines, the performance of methanol and gasoline blends, alcohol diesel emulsions, dual fuel systems, and emission characteristics.	06
3.	Hydrogen and Fuel cells Properties of hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production, transportation, storage, application and economics of hydrogen. Hydrogen, methanol fuel cells, power rating, and performance. Heat dissipation, the layout of a fuel cell vehicle.	06
4.	Bio-Diesels Jatropha oil, Karanji oil, Neem oil, Rice bran oil, Linseed oil, Sunflower oil, DME, properties, diesel and biodiesel blends, engine performance	06
5.	Gaseous Fuel L.P.G., C.N.G., bio-gas, their properties as engine fuels, fuel metering systems, combustion characteristics, effect on performance and emission, cost, and safety.	06



6.	Electric and hybrid vehicles The layout of electric vehicles, advantages and limitations, significations, system components, and electronic controlled systems. Solar Power, Solar cells for energy collection, the layout of solar powered automobiles.	06
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References:

Text Books:

- Thipse, S. S. "Alternative fuels "; Jaico.

Reference Books:

- Shyam Agrawal, Internal Combustion Engines, New Age International.
- Edward F. Obert, Internal Combustion Engines and Air Pollution, Addison Wesley,
- Litchty L. C., Internal Combustion Engines, McGraw Hill Book Co., New Delhi.
- G. D. Rai, Non-Conventional Energy Sources, Khanna Publications, Delhi.
- Vishwanathan B and M AuliceScibioh, Fuel Cells, Universities Press, Hyderabad, India.
- R D Begamudre, Energy Conversion Systems, New Age International (P) Ltd., Publishers, New Delhi.
- J. Twidell and T. Weir, Renewable Energy Resources, Taylor and Francis (special Indian edition)
- Hans P. Blaschek, Thaddeus Ezeji, Jürgen Scheffran, Biofuels from Agricultural Wastes and Byproducts, Wiley Blackwell.



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 Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering
Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3484	Course Name: Computer Integrated Manufacturing	3	--	--	3

Course Description:

Computer Integrated Manufacturing (CIMS) is course offered at the third year of B. Tech. (Mechanical) program. Prerequisites to this course are knowledge of manufacturing processes, machine tools, tool engineering etc. This course covers advanced manufacturing processes like Group Technology, Flexible Manufacturing Systems.

Course Learning Outcomes:

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

1. Describe and classify computer-integrated manufacturing systems (CIMS)
2. Explain the principle of operation of CNC machine
3. Describe part family forming methods
4. Perform quantitative analysis of Flexible Manufacturing Systems (FMS)
5. Analyze various computer integrated planning and control techniques
6. Explain the modern trends in Manufacturing like Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

Course Content

Unit No	Description	Hrs
1.	Introduction Meaning, scope, applications, CIMS classification based on flexibility and production volume, Evolution of CIMS, Elements of CIMS, Material handling systems in CIMS, Automated storage and retrieval systems (ASRS), Functions of computer in CIMS, CIMS benefits and limitations. Obstacles to CIMS. Socio-economic impact of CIMS.	06
2.	CNC machine Tools Numerical control (NC) of machines, Computer Numerical Control (CNC) of machines, direct numerical control, Principle of operation of CNC machines. CNC Control systems, Analysis of control systems, Construction features of CNC machines, Guideways, ball screws. CNC Machine types.	06
3.	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 – Rank Order Clustering Method	06
4.	Flexible Manufacturing Systems Need, meaning and scope of FMS, FMS classification, Components of FMS, Flexibility. Quantitative analysis of FMS, FMS benefits. Flexibilities, Automatic tool changers.	06
5.	Computer-Assisted Production Planning and Control	06





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Curriculum Structure and Evaluation Scheme
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Department of Mechanical Engineering

	Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Computer integrated production management system, computer Aided Quality Control, Shop floor control.	
6.	Future of Automated Factory Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	06

References:

Text Books:

- Dr. P. Radhakrishnan, S. Subramanyam, V. Raju, CAD/CAM/CIM, New Age International Publisher
- M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, 4th, Prentice Hall

Reference Books:

- Bedworth, Henderson, Wolf, Computer Integrated Design and Manufacturing, McGraw Hill
- S. Kant Vajpayi, Principles of Computer Integrated Manufacturing, Prentice Hall of India





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T.Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3504	Course Name: Total Productive Maintenance	3	--	--	3

Course Description:

This subject will entail the primary focus of constant improvement in the overall equipment effectiveness (OEE) as it relates to equipment and capital assets. TPM focuses on getting managers, maintenance personnel and equipment users all working together to prevent equipment problems and reduce expenditures. By giving ownership and responsibility of equipment and processes to the right employees, equipment breakdowns are reduced. TPM brings maintenance into focus as a necessary and vitality important part of the business. TPM is used at all levels of the organization.

Course Learning Outcomes:

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

1. Explain the objectives of Total Productive Maintenance (TPM)
2. Determine the Overall Equipment Effectiveness (OEE)
3. Explain the 12 steps of TPM implementation
4. Explain the Pillars of TPM.
5. Describe Computerized Maintenance Management System (CMMS)
6. Explain tools in TPM.

Prerequisite:

Basic knowledge of maintenance engineering and management

Course Content		
Unit No	Description	Hrs
1.	Basics of TPM Introduction to TPM concept, Objectives and functions, Reliability Centered Maintenance (RCM), Maintainability prediction, Availability and system effectiveness, Maintenance cost, pillars of TPM	06
2.	Implementation of TPM Developing the TPM Implementation Plan, Types of abnormalities in TPM, Primary Types of Preventive Maintenance, Essential Elements of Effective Preventive Maintenance Plans, preventive maintenance scheduling, floating preventive maintenance scheduling.	06
3.	Organization of TPM Three zeros, Strategies to Improve Overall equipment effectiveness, TPM Small Group activities, TPM Organization, TPM Implementation, Maintenance Inventory Control, Maintenance Efficiency.	06
4.	Components of TPM Human factors in maintenance, Maintenance manuals, Maintenance staffing methods, Spare parts management, maintenance planning and scheduling, Condition Monitoring.	06



5.	Maintenance Management Information Systems Maintenance Management Information Systems, Computerized Maintenance Management System (CMMS), CMMS Functionality, Application of CMMS-maintenance, engineering, production, inventory control, Purchasing.	06
6.	Tools in TPM TPM initial cleaning, Problems Caused by Insufficient Cleaning, Fuguai, F-tagging, Golden Rules of TPM, The Sengen Principle, TPM's Three Principle Theory, Ownership with TPM: Preventing Troubles, success of TPM.	06

References:

Text Books:

- Seiichi Nakajima, Introduction to TPM, productivity press, Chennai
- Gopala Krishnan, P and Benerji A. K., Maintenance and Spair Parts Management, Prentice Hall of India Pvt. Ltd.

Reference Books:

- Tina Kanti Agustiady, Elizabeth A. Cudney, 'Total Productive Maintenance: Strategies and Implementation Guide', Productivity Press
- Kern Peng, 'Equipment Management in the Post-Maintenance Era: A New Alternative to Total Productive Maintenance (TPM)', Productivity Press
- David J. Sumanth, 'Total Productivity Management (TPMgt): A Systematic and Quantitative Approach to Compete in Quality, Price and Time', Productivity Press
- Fumio Gotoh, Masaji Tajiri, 'Autonomous maintenance in Seven Steps: Implementing TPM on the ShopFloor', Productivity Press





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Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3524	Course Name: Tool Engineering	3	--	--	3

Course Description:

Tool Engineering is offered as the core course at the S. Y. B. Tech. (Mechanical Engineering) (Sem. IV) Under graduate program. This course consists of study of theory of metal cutting, Tool geometry of single and multi-point cutting tools to recognize the importance various angles provided on the cutting tools. It also covers design of small tools such as press tools, jig and fixtures.

This course intends to build competency in the students to design the processes, monitor the metal cutting operations on the shop floor, design and develop production devices, to carry out the cost and benefit analysis of new tools and production devices

Course Learning Outcomes:

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

1. Explain the mechanism of metal cutting.
2. Analyze the effect of various parameters such as process variables, cutting tool materials etc. on the performance of machining.
3. Explain the importance of the various elements of tool geometry of single and multi-point cutting tools.
4. Design jigs and fixtures for given components.
5. Design press tools for cutting and forming press working operations.
6. Estimate machining cost.

Prerequisite:

1. Knowledge of engineering materials their properties and applications.
2. Knowledge of primary and secondary manufacturing processes viz. casting, forging, rolling, turning, milling grinding, press working operations etc.
3. Knowledge of machine tools such as engine lathe, production lathes, automatic lathe, milling, drilling, grinding etc.

Course Content		
Unit No	Description	Hrs
1.	Theory of metal cutting Cutting tools, tool geometry, concept of speed, feed, depth of cut, cutting action, cutting forces, estimation of cutting forces, Merchant's circle of forces, Measurement of cutting forces & power required, machinability, tool life.	06
2.	Tool geometry Parts, angles and types of single point cutting tools, tool geometry of single point cutting tool, tool geometry of multipoint cutting tools. -drills, milling cutters, reamers, Broaches.	06
3.	Design of cutting press tools Dies, punches, types of presses, clearances, types of dies, strip layout, calculation of press capacity, center of pressure, Design consideration for die	06



	elements.	
4.	Design of forming press tools Drawing dies , Deep draw-ability, Design considerations: radius of draw die, punch radius, draw clearance, drawing speed, calculating blank sizes, number of draws, drawing pressure, blank holding pressure, Bending dies . Bending methods: V bending, edge bending, Design principles: bend radius, bend allowance, spanning, width of die opening, spring back, bending pressure, bottoming force,	06
5.	Design of jigs & fixtures Definition, elements, Types of location, their selection, clamping. Types of Jig bushes, indexing methods. Types of Jigs, Design of Jigs. Essentials of milling fixtures, Simple milling fixture, Line or string milling fixtures, indexing milling fixtures	06
6.	Process planning, Cost estimation & Machining time calculation Process planning for machined components. Cost accounting or costing, Element of cost, Estimation of cost element, Methods of cost estimating, Data requirement for cost estimating, steps in making a cost estimate, Chief factors in cost estimating. Calculation of machining times, Estimation of total unit time	06

References:

Text Books:

- P. C. Sharma, Production Engineering, S. Chand Publication.
- A. Bhattacharya, Metal cutting: Theory & Practice, 3rd, New central book agency.

Reference Books:

- C. Donaldson, Tool design, Tata McGraw Hill.
- G. R. Nagpal, Tool engineering design, 2nd, Khanna publication.
- R. K. Rajput, Manufacturing Technology, Laxmi publication.
- P. H. Joshi, Jigs and Fixtures, Tata McGraw hill.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI	L	T	P	Credits
Course Code: ME3544	Course Name: Industrial Organization and Management	3	--	--	3

Course Description:

The aim of the course is to give students theoretical insights and practical tools within the area of management and organization of industrial corporations. The course will provide students with different perspectives in order to understand the phenomena of management and organization and connect it to their future area of work. Further, this course will develop managerial skills to position different areas together to fulfill objectives of the organization.

Course Learning Outcomes:

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

1. Recognize the factors that influence business environment and visualize their effect on business.
2. Appraise the scope and objectives of functional areas of business and their integration.
3. Formulate an effective and efficient solution for business problems.
4. Identify several ways in which financial accounting information is used to make business decisions.
5. Apply engineering economics principles for evaluation of a business.

Prerequisite: Not required

Course Content		
Unit No	Description	Hrs
1.	Overview of Business Environment Types of Businesses, Definition of Management Business Environment- Nature, scope and objectives of business, National & Global Perspective, Environmental Analysis and Forecasting, Factors Affecting the Business- Economic Environment, Political and government Environment, natural and Technological Environment, Business and Society, Industrial Policies and Regulations, Economic planning and Development, Global Environment- GATT/WTO and Global Liberalization, international Investments, Multinational Corporations, Globalization	06
2.	Basic Functions of Management Planning – Need, Objectives, Strategy, policies, Procedures, Steps in Planning, Decision making, Forecasting. Organizing – Process of Organizing importance and principle of organizing, departmentation, Organizational relationship, Authority, Responsibility, Delegation and Span of control.	06
3.	Human Resource Management Nature, Purpose, Scope, Human resource planning, Policies, Recruitment procedure training and development, appraisal methods.	06



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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

	Leading – Engineer as a leader, Engineer as a manager, leadership skills for 21 st century, Communication process, Barriers, remedies, motivation, importance, Theories: Herzberg's theory, Maslow's theory, McGregor's theory, leadership styles. Controlling – Process, requirement for control management, accountability. Engineering Change Management, Ethical Business Practices	
4.	Materials Management Definition, Scope, advantages of materials management, functions of materials management, Purchase Objectives, 5-R Principles of purchasing, Functions of Purchase department, Purchasing cycle, Purchase policy & Procedure, Evaluation of Purchase Performance. Inventory Control	06
5.	Marketing Management Marketing Concepts –Objective –Types of markets – Market Segmentation, Market strategy – 4 AP's of market, Market Research, Salesmanship, Advertising.	06
6.	Financial Management and Engineering Economics Introduction, Sources of finance, Financial Institutions, Financial statements, Balance sheet and P & L accounts. Engineering Economics – Introduction, Time value of money, Cash flows, Annuity, Depreciation, Investment decision for capital assets. (Numerical approach)	06

References:

Text Books:

- M. T. Telsang, "Industrial and Business Management", S. Chand & Co.
- J. P. Bose, S. Talukdar, "Business Management", New Central agencies (P) Ltd.

Reference Books:

- Francis Cherunilam, "Business Environment", Himalaya Publishing House.
- James A. F. Stoner, R. Edward Freeman, "Management", Prentice Hall of India New Delhi.
- Gene Burton and Manab Thakur, "Management Today- Principles and Practice", Tata McGraw Hill Publishing Company, New Delhi.
- Koontz & O'Donnell, "Essentials of Management", McGraw-Hill Publication.
- Philip Kotler, "Marketing Management", Prentice Hall of India, New Delhi.





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Program Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI
Course Code: ME368	Course Name: Robot Dynamics and Applications

L	T	P	Credits
3	--	--	3

Course Description:

This course is intended for third year graduate students from a wide variety of engineering disciplines. We will emphasize the basics of motion and force control mostly for serial robotic manipulators. Transformations from task space to joint space will allow joint level control. The study of forward and inverse kinematics, along with differential kinematics will provide a foundation for designing robots and their controllers. We will examine robots operating in free spaces as well as in contact with environments. Advanced topics will look at the dynamics and control of other under actuated and mobile robotic systems. It is assumed the students have a basic knowledge of rigid-body dynamics and linear control theory.

Course Outcomes:

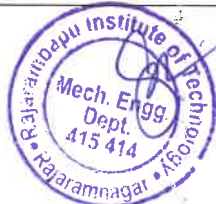
After successful completion of the course, student shall be able to:

1. Identify various types of Robots for industrial applications with sound knowledge of the positioning system.
2. Explain the rigid body motion and its transformation mathematically.
3. Solve and model the kinematics equations of various manipulator
4. Solve and model the differential motion and dynamics of various manipulator configurations.
5. Compute the collision-free trajectory planning.
6. Identify the challenges and control problems in manipulator robotics.

Prerequisite: Nil

Course Content

Unit No.	Description	Hrs
1.	Anatomy and Positioning System of robot Introduction to Industrial robotics – Manipulator configuration (examples with product specification): two link planar, Cartesian, Cylindrical, Polar, Articulated, SCARA, Delta and Stewart platform – CAD modelling of manipulator configuration (students by own) – Analysis of Positioning Systems (Actuator + Gear reduction unit): open-loop study with stepper motor, Closed-loop study with servo motor – Precision in Positioning system: control resolution, accuracy and repeatability– Harmonic drives in robotic manipulators.	06
2.	Configuration space and Rigid body motion DOF – C-space: Topology and representation, velocity constraints – Rigid body Motion: Description of position, orientations and frames – Changing descriptions from frame to frame (Homogeneous matrix) – Operation: Translation, rotation (rotation and Euler matrix) and transformation – Denavit-Hartenberg representation – Numerical.	06



3.	Robot kinematics Forward and Inverse kinematics: Two link planar (RR), cylindrical robot (RPP) and articulated arm (RRR) with Modelling and 3D virtual realization – other manipulators configurations: 6DOF articulated robotic arm, SCARA and Stewart platform	06
4.	Differential motion and dynamics of robot Angular velocity – Velocity kinematic: Jacobian for 2 link planar (RPP), cylindrical robot (RPP) and articulated arm (RRR) – Forward and inverse dynamics of simple pendulum, double stage pendulum and two link planar.	06
5.	Manipulator Trajectory planning Path Planning – Trajectory planning – Classification of Trajectory planning - Join space schemes: Cubic polynomials – Cubic polynomials via point – Higher order polynomials – Linear function with parabolic blends – Cartesian space schemes: Geometric problems with Cartesian paths – two link planar trajectory planning.	06
6.	Manipulator control Linear control of manipulator: second-order linear system, control of second order system trajectory following control, disturbance rejection – Non-linear control: Control problems in manipulators, multi-input and multi-output control system – Lyapunov stability analysis –adaptive control.	06

References:

Text Book

- Craig, John. J., Introduction to Robotics: Mechanics and Control, Pearson Education, New Delhi.
- Robot Modeling and Control, by Spong, Hutchinson and Vidyasagar

Reference Books

- Bruno Siciliano Robotics Modelling, Planning and Control, Springer-Verlag London Limited.
- Mikell P. Groover, Mitchell Weiss, Industrial Robotics Technology – Programming and Applications, McGraw Hill.
- F. C. Park and K. M. Lynch, Introduction To Robotics Mechanics, Planning, And Control, Cambridge University Press.
- Gareth J.Monkman, Stefan Hesse, Robot Grippers, WILEY-VH Verlag GmbH and Co, KGaA, Weinheim.



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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech	Semester-VII
Course Code: ME 382	Course Name: Process Equipments and Engineering

L	T	P	Credits
3	--	--	3

Course Description:

The Process equipment design course offered to T.Y. B.Tech in Mechanical Engineering is concerned with chemical, mechanical, material process industry and their related equipment. The Mechanical design has been taught in the particular course along with introduction to various process equipment. An information about plant layout and piping and Industrial standards has also been provided.

Course Learning Outcomes:

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

1. Outline the basics of chemical/Material process plant/equipment.
2. Design and draw a pressure vessel as per the given process conditions.
3. Design and draw a storage vessel for various materials.
4. Design and draw a reaction vessel as per the given conditions.
5. Design and draw a heat exchanger with all manufacturing details.
6. Outline the piping network, plant layout and create piping design for plants and P & ID.

Prerequisite:

Fluid Mechanics and dynamics, Heat Transfer, Strength of Material, Mechanical Component Design and Machine Design.

Course Content		
Unit No	Description	Hrs.
1.	Basic Design Concepts Use of standards and design stresses and factor of safety, selection of materials, working conditions, corrosion and its effects on Equipments. Standard design codes, Heat and Mass transfer concepts.	04
2.	Design Of Pressure Vessel Stresses acting on pressure vessels, operating conditions, selection of materials, pressure vessel codes, design stress and design criteria. Design of Shell, Head, Nozzle, Flanged joints for heads and nozzles,	07
3.	Design of Storage Vessels Storage of various types of fluids and liquids in tanks, Loss mechanism of	06



	storage of volatile and non-volatile liquids and gases, Types of storage vessels, Vessels for storing of gases, method of storage of gases, Design of rectangular and cylindrical tank with components such as shell, bottom plate, self-supporting roof design, types of roofs,	
4.	Mechanical Design of Reaction Vessel a) Design of shells subjected to internal and external pressures. b) Types of Jackets /Coils used for heating and cooling in reaction vessels and their design. c) Type of agitators and their design. Design of agitator system components such as shafts, stuffing box etc.	06
5.	Mechanical Design of Heat Exchangers a) Components of shell and tube type heat exchangers. b) Design of various components of heat exchangers such as Fixed tube sheet type, U tube, Floating head etc. Various codes for heat exchangers	06
6.	Industrial Piping Design Basic pipe flow concepts, flow through pipes, Pipe supports and joints, Piping load analysis and Design, Plant Layout and piping design, Process and instrumentation diagrams, Industrial piping codes, Introduction to softwares used for piping design.	07

References:

Text Books:

- Mahajani, V. V., and S. B. Umarji. - Joshi's Process Equipment Design. Laxmi Publications Pvt Ltd.

Reference Books:

- Brownell, Lloyd E., and Edwin H. Young. - Process equipment design: vessel design. John Wiley & Sons.
- ASME Section -VIII BPVC 1 and 2
- Liang Chung Peng-Pipe Stress Engineering (1st Edition),
- ASME US. 2009
- Moe Toghræi- Piping and instrumentation Diagram development, John Wiley and Sons Inc.



K.E. Society's
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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Open Elective-II

Class: T.Y. B. Tech Mech.	Semester: VI
Course Code: 3024	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.

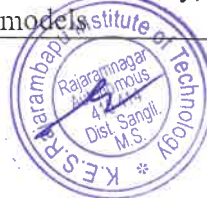
Course Learning Outcomes:

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.

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	06
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	06
3.	Reliability Allocation Definition, reliability allocation techniques, equal apportionment, AGREE method, ARINC method, feasibility of objectives apportionment technique, minimum effort method	06
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	06



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,	06
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	06

References:

Text books:

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

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, 3rd Edition 1998
- Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Springer, 2007
- Roger D Leitch, Reliability Analysis for Engineers: An Introduction, Oxford University Press, 1995
- S S. Rao, Reliability Based Design, Mc Graw Hill Inc. 1992
- 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..





K.E. Society's
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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Open Elective-II

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

Course Description:

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

Course Learning Outcomes:

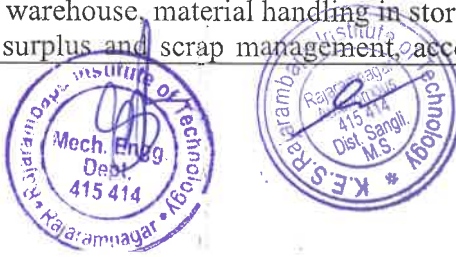
After successful completion of the course, students will be able to,

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

Prerequisite:

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

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



	keeping of stores	
5.	Inventory Management and Control ABC analysis- advantages, mechanism, purpose, objectives Importance & Scope of Inventory Control, Types of Inventories, Costs Associated with Inventory, Inventory Control, Selective Inventory Control, Economic Order Quantity, Safety Stocks	06
6.	Materials Requirement Planning (MRP) Introduction, objectives, Terminology, Functions served by MRP, MRP Logic, systems and output, Management information form, Lot size consideration, Introduction to Manufacturing resource planning (MRP II)	06

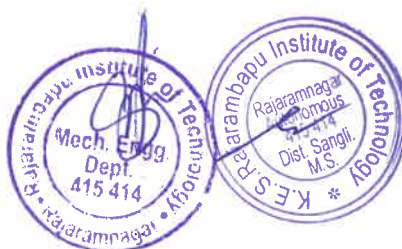
References:

Text Books:

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

Reference Books:

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





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Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering
Open Elective-II

Class: T. Y. B. Tech Mech.	Semester: VI
Course Code: OE3182	Course Name: Industrial Drives

L	T	P	Credits
3	--	--	3

Course description:

This course deals with the basics of electrical machines and power electronic drives. This course provides the knowledge about AC Drives, DC Drives and special purpose drives used in various industries. The operating principles as well as control of each drive systems is also covered in the syllabus.

Course Learning Outcomes:

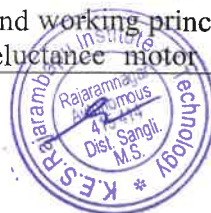
After successful completion of the course, students will be able to,

1. Analyze stability, moment of inertia, speed and torque in industrial drive system.
2. Elaborate energy conservation in industrial drive system.
3. Identify various sensors required for industrial drives.
4. Compare various control strategies for AC and DC drives.
5. Select special motors for industrial applications.

Prerequisite:

Basic Electrical Engineering.

Course Content		
Unit No.	Description	Hrs.
1.	Introduction to industrial drives Basic electric drives and its components, Types of loads, coupling systems, factors for choice of drives, Fundamental torque equation, speed torque conventions, equivalent values of drive parameters, thermal modelling of motor, classes of motor duty.	06
2.	Energy conservation in industrial drives Concept of energy conservation, losses in drive system, Measures for Energy Conservation in industrial drives, use of efficient converters, use of efficient motors, improvement of quality of supply, improvement of p.f. maintenance of drive system, safety and maintenance aspects in industrial drives	06
3.	Sensors for Industrial drives Introduction to sensors, Force measuring sensor, Load cells, Torque measurement, speed measurement, tachometers and angular speed detectors, piezoelectric transducer, hall Effect transducers, case study of sensors.	06
4.	Control of AC and DC Drives Introduction to converters for electrical drives, Modes of operation, closed loop torque and speed control, closed loop control of multi-motor, converter & chopper fed DC motor drives, rotor resistance & V/f control of AC drives, Types of braking	06
5.	Stepper-Motor and Switched-Reluctance Drives Introduction to stepper motors, construction and working principle, control of stepper motor, Introduction to switched reluctance motor drives, torque	06



	characteristics, Voltage impulse control, Current control, Torque control converter topologies, SRM drive design factors, Industrial applications.	
6.	BLDC and Servo Motor Drives Principle of operation of BLDC Machine, Sensing and logic switching scheme, Speed control of BLDC drive, Low-Cost Brushless DC Motor Drives, Introduction to servo mechanism, types of servo motors, servo motor drive, Brushless DC Motor Drive for Servo Applications, Industrial applications.	06

References:

Text Books:

- Gopal K Dubey, Fundamentals of Electrical Drives, Narosa publication.
- Vedam Subrahnyam, Electrical Drives Concepts and applications, Tata McGraw Hill publication.

References:

- Sawhney. A.K, A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai & Company Private Limited.
- B.K. Bose, Modern power Electronics and A.C. Drives, Pearson Education.

Open Elective-II

Class: T. Y. B. Tech	Semester: VI	L	T	P	Credits
Course Code: OE3284	Course Name: Supply Chain Management	3	--	--	3

Course Description:

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

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

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

Course Learning Outcomes:

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

1. Identify the role and key issues in 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.

Prerequisite: Nil.

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.





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-II

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

Course Description:

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

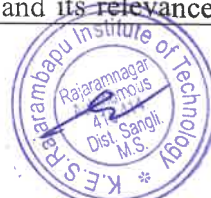
1. Identify, analyze & select business opportunity to suit his personality based on SWOT analysis.
2. Make market research & survey for selected business.
3. Prepare and apprise detailed Project Report.
4. Formulate plan for financial management of project.
5. Apply managerial inputs for starting & establishing his own business.

Prerequisite:

Students 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. 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	06



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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

References:

Text Books:

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

Reference Books:

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





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-II

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 & 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,

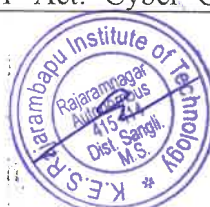
1. Describe fundamental terms in cybercrime legislation.
2. Compare various cyber-attacks & offences.
3. Analyze the Indian IT Act 2000 & amendments in the IT Act.
4. Assess social networks and security issues related to social media platforms.
5. Apply a strategy for creating awareness about cyber security 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),	05



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

References:

Text Books:

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

Reference Books:

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





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(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-II

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

Course Description:

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

Course Learning Outcomes:

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

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.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-II

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

Course Description:

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

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

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

Course Learning Outcomes:

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

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.

Prerequisite:

Write prerequisite required to study this course.

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	06



	information; A framework for structuring drivers in supply chain, supply chain strategies, strategic fit, Obstacles to achieve strategic fit, value of information.	
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.



Open Elective-II

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

Course Description:

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

Key components and aspects of mobile robotics include 1. Sensors 2. Actuators 3. Control Systems 4. Power Systems 5. Communication 6. Autonomy. One of the defining features of mobile robots is their ability to operate autonomously, meaning they can make decisions and navigate without direct human intervention. This autonomy can range from simple behaviors, like obstacle avoidance, to complex tasks such as mapping an unknown environment. Applications of mobile robotics are diverse and include Autonomous Vehicles: Self-driving cars, drones, and other autonomous vehicles are examples of mobile robots used for transportation and surveillance.

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

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

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

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

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

Course Learning Outcomes:

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

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

Reference Books:

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





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-II

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

Course Description:

This Course represent basic Knowledge of Information Technology subject to entry level Engineers from different background and discipline to deliver world class projects to global customer. The purpose of this course is to trained to entry level engineer to help them make industry ready.

Course Learning Outcomes:

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

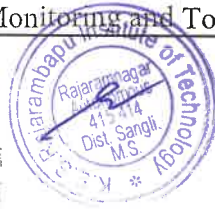
1. Solve the real-world problem using Programming Concept.
2. Apply Data Structure Algorithm to solve Computational Problem.
3. Make use of an ER model for a given problem domain.
4. Relate the relationship between project integration, scope, cost and time Management System to improve quality of projects.

Prerequisite:

Basic Knowledge of Computer System and Programming language

Course Content

Unit No	Description	Hrs
1	Problem Solving Techniques Introduction to Logic, Problem Solving, Algorithms, and Flowcharts.	6
2	Fundamentals of C and Data Structures Introduction to C, Basic Programming, Selection Control Structure, Iteration Control Structure, Demonstration of 1D and 2D arrays, Function, Strings. Introduction to basic data structures, Searching and Sorting Algorithms.	6
3	Programming Paradigm Introduction of Programming Paradigm, Coding Standards, Best Practices, , Introduction to code optimization, Modular approaches through Functions, Testing and Debugging.	6
4	Object Oriented Concepts Introduction to Object Oriented Programming, C versus C++, Features of OOP, Constructor, Destructor, Inheritance, Polymorphism.	6
5	Relation Database Management Introduction, ER modelling, SQL Queries.	6
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.	6





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Rajarambapu Institute of Technology, Rajaramnagar
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books

- Aho-Ullman, Addison wesely. "Data Structure and algorithm". Perrson Publication.
- E Balagurusamy, Object-Oriented Programming with C++ ,McGraw,Publication.
- Henorykorth, Database system concepts',MGM International.
- Information Technology Project Management, Kathy Schwalbe, Thomson Course Technology, Fourth Edition.



Open Elective-II

Class: T. Y. B. Tech.	Semester: VI	L	T	P	Credits
Course Code: OE350	Course Name: Operations Research	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), ($2 \times n$).	06
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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.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Open Elective-II

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

Course Description:

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

Course Learning Outcomes:

After completion of this 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, smoothing and sharpening spatial filter.	06
3	Morphological Image Processing Dilation and erosion, opening and closing operation, Hit or miss transformation, Edge Detection, Applications of Morphological Image Processing.	06
4	Image Segmentation Thresholding, Role of illumination, global and adaptive thresholding, pixel-based segmentation, region-based segmentation and edge-based segmentation.	06
5	Image Shape and Classification 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
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References:

Text Books:

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

Reference Books:

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



Open Elective-II

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



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 Curriculum Structure and Evaluation Scheme
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 Department of Mechanical Engineering

Open Elective-II

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

Course Description:

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

Course Learning Outcomes:

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

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: 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.	06
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.



Open Elective-II

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

Course Description:

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

Course Learning Outcomes:

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

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, 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	06

	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.



Open Elective-II

Class: T. Y. B. Tech.	Semester- VI	L	T	P	Credits
Course Code: OE362	Course Name: Flexible Manufacturing Systems	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 Learning 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, signaling, 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 M. M., and 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:

- Kalpakjian, *Manufacturing Engineering and Technology*, Addison-Wesley Publishing Co.
- N. Viswanadham and Y. Narahari, *Performance Modelling of Automated Manufacturing Systems*, PHI.
- Michael Pinedo and Xiuly Chao, *Operations Scheduling with Applications in Manufacturing and Services*, McGraw Hill International Editions.
- A. K. Kamrani and E. A. Nasr, *Rapid Prototyping: Theory and Practice*, Springer.

Open Elective-II

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

Course Description:

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

Course Learning Outcomes:

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

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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Curriculum Structure and Evaluation Scheme
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Department of Mechanical Engineering

Open Elective-II

Class: T. Y. B. Tech	Semester: VI	L	T	P	Credits
Course Code: OE366	Course Name: AI for Cybersecurity	3	-	-	3

Course Description:

This course explores the integration of AI and cybersecurity, covering key concepts, frameworks, and machine learning techniques for threat detection, malware analysis, and network security. Students will gain hands-on experience with AI tools for penetration testing, log analysis, and security automation, while also learning about responsible AI use and future trends in cybersecurity.

Course Learning Outcomes:

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

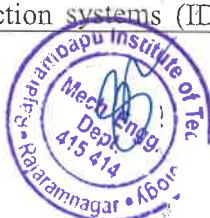
1. Describe fundamental concepts of cybersecurity, AI, and key frameworks.
2. Use Python and machine learning tools for basic malware and anomaly detection tasks.
3. Examine and differentiate AI techniques for threat detection, intrusion detection, and network security operations.
4. Design and evaluate AI-driven solutions for vulnerability management, log analysis, and security dashboard development.

Prerequisite:

Basic knowledge of networks, Machine learning concepts and cybersecurity concepts.

Course Content

Unit No	Description	Hrs
1.	Foundations of AI-Driven Cybersecurity Overview of Cybersecurity and AI concepts, Intersection of Cyber Security and Artificial Intelligence (AI), Applications of AI for solving real-world challenges, CIA Triad Modelling-Addressing trade-offs and conflicting priorities, Cybersecurity Framework Prevention, detection, and response, NIST AI Risk Management Framework, Traditional cyber threats, Introduction to OWASP Frameworks and risks documentation	6
2.	Machine Learning and Generative Models for Cybersecurity AI applications in cybersecurity, AI project cycle, future trends in AI-cybersecurity integration, Python Libraries Scikit-learn, TensorFlow and scripting for cybersecurity tasks. Supervised Learning: Basics, malware detection, anomaly detection for critical infrastructure, threat detection models. Unsupervised Learning: Anomaly detection (hands-on), clustering for threat analysis. Generative Adversarial Networks (GANs), threat detection/prevention using generative AI. Hands-On: Implementing generative AI tools	6
3.	AI-Powered Threat Detection and Malware Analysis Security Innovation for Threat Detection, Behavioral Analytics with AI, AI for Intrusion Detection systems (IDS), Threat Hunting and Detection	6



	Intelligence, Adversarial Attack Detection and Mitigation, Basics of malware analysis techniques, Automated malware detection and classification, Introduction to tools using AI for malware analysis, Dynamic and Static Analysis, AI-Powered Sandboxing	
4.	AI in Network Security AI-driven network traffic analysis, Identifying network intrusions and attacks, AI-enhanced Network Access Control (NAC), AI-based firewalls and network segmentation, Secure Software-Defined Networking (SDN), Introduction to AI-based SOAR (Security Orchestration, Automation, and Response), Introduction to SIEM (Security Information and Event Management) systems, Investigation, containment, remediation, recovery, and reporting with AI, Hands-on: Data dashboarding for security operation reports, Hands-on: AI-powered spam detection, Automated security management techniques	6
5.	AI in Vulnerability Management Key requirements to Penetration Testing with AI, Automated OSINT and Social Engineering with AI, Vulnerability scanning and prioritization, Dashboard development for vulnerability intelligence, Introduction to Open-source bug hunting barriers, Applications of AI Fuzzing in bug bounty, AI-Assisted Exploitation and Attack Simulations, AI applications in CAPTCHA development and decoding.	6
6.	Future Trends in Log Management and AI Security Log Analysis in Cybersecurity, Log Management using extended detection and response (XDR), Augmenting log analysis with AI tools, Hands-on: Use ELK Stack (Elasticsearch, Logstash, Kibana) for log analysis, Governance through responsible AI frameworks in cybersecurity, The future of AI security challenges and mitigations, Role of advanced threat detection systems in data protection, Apply cybersecurity and AI concepts in practical, dashboarding project	6

References:

Text Books:

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

Reference Books:

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



Open Elective-II

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

Course Description:

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
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References:

Text Books:

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

Reference Books:

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





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Curriculum Structure and Evaluation Scheme
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Department of Mechanical Engineering

Open Elective-II

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

Course Description:

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

The course will be Open Elective choice for all students

Course Learning Outcomes:

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

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	06



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

References:

Text Books:

- 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





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Curriculum Structure and Evaluation Scheme

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Department of Mechanical Engineering

Open Elective-II

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. Assess market opportunities by analyzing customers, competitors, collaborators, and the strengths and weaknesses of a company.
2. Develop effective marketing strategies to achieve organizational objectives.
3. Design a strategy implementation program to maximize its chance of success.
4. Examine how marketing strategies impact the profitability of an organization
5. Communicate and defend your recommendations to your classmates both quantitatively and qualitatively.

Prerequisite: Nil.

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. Global Marketing.	06
6.	Strategy An Introduction, Dealing with competition, Porter's five force model, Strategy, Strategy execution.	06

References:

Text Books:

- Philip Kotler, Kevin Lane Keller, "Marketing Management", Pearson Publications.
- Rajan Saxena, "Marketing Management", The McGraw-Hill Companies Publication.

Reference Books:

- Vijay Prakash Anand, *Marketing Management – An Indian Perspective*, Wiley India Pvt. Ltd.
- Joel R. Evans, Berry Berman, *Marketing Management*, 1st Edition, 2018.
- James C. Anderson, James A. Narus, Das Narayandas, *Business Market Management: Understanding, Creating, and Delivering Value*, Prentice Hall.
- Stephen Wunker, *Capturing New Markets: How Smart Companies Create Opportunities Others Don't*, McGraw-Hill Education.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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 successfully completing the course, student will 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.

Course Content		
Unit No.	Description	Hrs
1.	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
2.	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
3.	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
4.	Wastewater Treatment Process Layout of Sewage Treatment Plant, wastewater treatment-Physical, chemical	06



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

	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.	
5.	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
6.	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
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme

To be implemented for 2023-27 Batch
Department of Mechanical 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: on completing this course, students will be able to

1. Understand the basic concepts and techniques of Artificial Intelligence.
2. Apply AI algorithms for solving typical practical problems.
3. Describe appropriate knowledge representation schemes in AI.
4. Apply reasoning schemes in AI.
5. Analyze the planning schemes for goal stack.
6. Evaluate performance of solution for constraint satisfaction problem.

Prerequisites:

Basic knowledge of logical reasoning and Probability theory.

Course Content		
Unit No	Description	Hrs
1.	Introduction Artificial Intelligence and its applications, Definitions of AI, Intelligent Agents, Concept of rationality, PEAS description of the task, Simple reflex agents, Model based agents, Learning Agents, advantages, Impact and Examples of AI, Application domains of AI.	06
2.	Problem solving techniques State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, best first search, A* search, Constraint satisfaction problem, Mean-end analysis, Game playing, Min-Max Search, Alpha-Beta Pruning. Iterative deepening.	06
3.	Logic and Knowledge Representation schemes in AI Propositional logic, predicate logic; Resolution, Resolution in propositional logic and predicate logic, Clause form, unification algorithm.	06
4.	Reasoning schemes in AI Introduction to non-monotonic reasoning, default reasoning, statistical reasoning, probability and Bayes' theorem, combining uncertain rules.	06
5.	Planning The Planning problem, planning with state space search, blocks world approach, Goal stack planning.	06
6.	Understanding Level of interactions among components, understanding as a constraint satisfaction, Line labeling, The Waltz algorithm.	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books:

- Artificial Intelligence by Rich and Knight, The McGraw Hill publication
- Artificial Intelligence: A modern approach by Stuart Russel, Peter Norvig, Third Edition, Pearson Education, 2010

Online Platforms:

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech	Semester- VI	L	T	P	Credits
Course Code: EEMD302	Course Name: Smart Grid	3	0	0	3

Course Description:

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

Course Learning Outcomes:

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

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.

Course Content		
Unit No	Description	Hrs
1.	Introduction to smart grid Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India, comparison between smart grid and micro grid, Grid Codes.	06
2.	Smart grid architecture 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
3.	Communication technology in smart grid Introduction to communication technology, Home Area Network (HAN), Neighborhood Area Network (NAN) and Wide Area Network (WAN), two-way digital communications paradigm, synchro-phasor measurement units (PMUs) – wide area measurement systems (WAMS), Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid.	06
4.	Information technology in smart grid Data communication, dedicated and shared communication channels, switching techniques- circuit switching, message switching, packet switching, virtual packet switching, datagram packet switching, standards for information exchange, information security for the smart grid,	06



5.	Distributed generation and storage Introduction to distributed energy sources, solar PV system, wind energy system, microgrids, microgrid architecture, AC micro grid, DC microgrid, storage technologies- battery, super capacitor, compressed air energy storage, pumped hydro energy storage, introduction electric vehicles- vehicle to grid (V2G), grid to vehicle (G2V), vehicle to vehicle (V2V) and vehicle to home (V2H) operation in smart grid.	06
6.	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.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

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

Course Learning Outcomes:

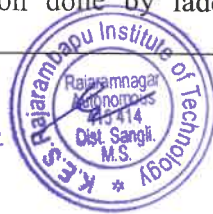
After successful completion of the course, students will be able to,

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
1.	Power Electronic Components Applications of power electronics, Power Electronic System, Power semiconductor devices: power diode, power BJT, Power MOSFET, IGBT, SCR, Diac, TRIAC, Ratings, control characteristics of power devices, Characteristics and specifications of switches, Types of power electronic circuits.	06
2.	Power Converters AC-DC Converters (Rectifiers), DC-DC converters (choppers), DC-AC converter (Inverters), AC-AC Converters (1-phase, 3-phase) Cycloconverters	06
3.	DC and AC Drives Basic characteristics of DC motor, operating modes, DC motor control using choppers and rectifiers, Torque-speed characteristics of induction motor, speed control techniques of AC motor: stator-voltage, rotor resistance, and v/f control, basic equations, characteristics.	06
4.	Introduction to PLC Introduction about industrial automation, History of industrial automation Need of automations in industries, Automation control circuit and power circuit, Control system in Industry, Types of PLCs	06
5.	PLC Programming Types of Programming Languages, Introduction about PLC Programming software, Ladder logic diagram, Structure of program, Procedure for creating ladder diagram, Logical function done by ladder program in software.	06



6.	Applications Industrial conveyor systems, Automatic Bottle Filling System, Traffic Light Control system, UPS, Battery charging circuits and management Systems, Induction heating and dielectric heating.	06
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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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

L	T	P	Credits
3	--	--	3

Course Description:

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

Course Learning Outcomes:

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

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.

Course Content		
Unit No	Description	Hrs
1.	Software Requirements, Analysis and Specification Software requirement analysis and specification, problem analysis, Requirement Specification, Validation, effort estimation, risk management, software testing types	06
2.	Software Process Models Waterfall model, V model, Prototyping, Spiral model, Agile software development	07
3.	Function-oriented Design Design principles, module level concepts, Design notation and specification, structured design methodology, Verification	05
4.	Structural Modeling using UML Classes, Relationships, Common mechanisms. Diagrams, Class Diagrams, Interfaces, Types and Roles, Packages, Instances and Object Diagram	06
5.	Behavioral Modeling and Architectural Modeling using UML Interactions, Use cases, Use case diagram, Activity diagrams, Events and signals, State Machines, Components, Deployment, Collaboration, Patterns and Frame works, Component diagrams and Deployment Diagrams	06
6.	Case studies	06



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

	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.	
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References:

Text Books:

- Pankaj Jalote, "An Integrated Approach to S/W Engineering.", Narosa Publication House, Eleventh edition, 2011
- 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, Seventh Edition, 2014





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

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

Course Learning Outcomes:

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

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 a new products
6. Create effective marketing communication plans and launch strategies for new products.

Course Content

Unit No	Description	Hrs.
1.	Product Positioning and Branding Strategies Understanding the concept of product positioning, Identifying target markets and audience segmentation, Crafting a compelling brand identity, Developing brand positioning strategies, Case studies and real-world examples of successful branding campaigns.	06
2.	Market Analysis and Segmentation Conducting market research to identify opportunities and threats, Analysing market trends and consumer behaviour, Segmentation techniques for targeting specific market segments, Assessing market competition and differentiation strategies, Utilizing data analytics tools for market analysis	06
3.	Pricing Strategies and Cost Estimation Factors influencing pricing decisions, Cost estimation methods for new product development, Pricing strategies: skimming, penetration, value-based pricing, etc., Pricing psychology and consumer perceptions, Pricing models and simulations	06
4.	Basics of Intellectual Property Rights and Patents Understanding intellectual property rights (IPR), Overview of patents, trademarks, copyrights, and trade secrets, Importance of protecting intellectual property for new products, Patent application process and requirements, Case studies on patent infringement and legal implications	06



5.	Distribution Channels and Sales Strategies Exploring various distribution channels: direct vs. indirect, Channel selection and management, Developing sales strategies and distribution plans, Sales forecasting and performance measurement, Building partnerships and alliances for distribution	06
6.	Marketing Communication and Launch Strategies Crafting effective marketing messages and communication channels, Integrated marketing communication (IMC) strategies, Planning and executing product launches, Leveraging digital marketing tools and social media platforms, Measuring the success of marketing campaigns and adjusting strategies accordingly	06

References:

Textbooks:

- 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 Keller K.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.



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Reference Books:

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





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Course Description:

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

Course Learning Outcomes:

After completing this course, students will be able to

1. Articulate basic concepts and techniques of Artificial Intelligence.
2. Apply AI algorithms for solving typical practical problems.
3. Designate appropriate knowledge representation schemes in AI.
4. Analyze reasoning schemes in AI.

Prerequisite:

1. Basic knowledge of logical reasoning
2. Probability theory.

Course Content		
Unit No	Description	Hrs
1.	Introduction The four categories of definitions of AI, Concept of rationality, The AI Problems, Artificial Intelligence Technique, Tic-Tac-Toe game and its data structure, Question-Answering and its one typical data structure, Sample few examples of the state-of-art AI applications.	06
2.	Intelligent Agents PEAS description of the task, Simple reflex agents, Model based agents, Learning Agents, advantages, Impact and Examples of AI, Application domains of AI.	06
3.	Problem solving techniques State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, best first search, A* search.	06
4.	Constraint satisfaction problem Mean-end analysis, Game playing, Min-Max Search, Alpha-Beta Pruning. Iterative deepening.	06
5.	Logic and Knowledge Representation schemes in AI Propositional logic, predicate logic, Resolution, Resolution in propositional logic and predicate logic, Clause form, unification algorithm.	06
6.	Reasoning schemes in AI Introduction to nonmonotonic reasoning, default reasoning, statistical reasoning, probability and Bayes' theorem, combining uncertain rules.	06





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

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

Online Platforms:

- Artificial Intelligence | Electrical Engineering and Computer Science | MIT OpenCourseWare





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech.	Semester: VI	L	T	P	Credits
Course Code: RAMD302	Course Name: Industrial Automation & Control	3	-	-	3

Course Description:

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

Course 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
1.	Fundamentals of Industrial Automation Need of automation, Types of Automation: fixed /programmable /flexible automation, Automation principles and strategies. Basic elements of automated systems: power, program and control, Advanced automation functions: Safety monitoring, Maintenance and Repair diagnostics, Error detection and recovery, Levels of automation.	06
2.	Transfer Lines and Automated Assembly Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications, Analysis of transfer lines with and without storage buffers. Assembly Automation: Types and configurations, Parts delivery at workstations.	06
3.	Fundamentals of PLC Programmable Logic Controller (PLC)- Block diagram of PLC, PLC architecture and programming languages (Ladder Logic, Function Block Diagram, etc.), Basic instruction sets, Input/output modules. Networking of PLC, Overview of safety of PLC with case studies.	06
4.	PLC Programming Basic instructions (AND, OR, NOT, Timer, Counter, etc.), Programming techniques (branching, looping, etc.), Program control instructions, PLC applications like motor control, light control etc.	06
5.	Material handling and Identification Technologies The material handling function, Types of Material Handling Equipment, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance,	06



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
 Curriculum Structure and Evaluation Scheme
 To be implemented for 2023-27 Batch
 Department of Mechanical Engineering

	Automated Storage/Retrieval Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID etc.	
6.	Distributed Control System Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	06

References:

Text Books:

- 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 Nostrand Reinhold Co. NY.
- Amber G.H & P.S. Amber, Anatomy of Automation, PrenticeHall.





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T. Y. B. Tech.	Semester: VI
Course Code: ME380	Course Name: Mechatronics and Automation

L	T	P	Credits
2	--	--	2

Course Description:

Mechatronics and automation introduce the basic principles of integrating mechanical, electrical, and control systems. The course covers sensors, actuators, microcontrollers, PLCs, and automation basics, providing a foundation for designing simple intelligent systems and automated processes.

Course Learning Outcomes:

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

1. Identify various elements of mechatronics systems.
2. Identify and select appropriate sensors and actuators for mechatronic applications.
3. Develop PLC/ microcontroller-based applications.
4. Explain fundamentals of SCADA, HMI Systems.

Prerequisite:

Basic Electrical Engineering, Basic Electronics Engineering.

Course Content		
Unit No	Description	Hrs.
1. Introduction:	Introduction to Mechatronics, Key elements of Mechatronics, Block diagram of mechatronics system, Role of automation in industries - architecture of industrial automation systems,	02
2. Sensors and Transducers	Transduction Principles and Classification. Classification of sensors, Need of Sensors, Working principles and applications of Proximity Sensors: Inductive sensors, Capacitive sensors, Thermal sensors, Magnetic sensors, photoelectric sensors, Shaft Encoders. Strain gauge, Selection of Sensors.	04
3. Drivers and Actuators	Introduction and Classification of Actuators. Need and Scope. Hydraulic Actuation systems – Linear, Single and Double Acting system, Pneumatic Actuation systems- Gear Motors and Vane Motors. Electrical Actuation Systems – solenoid type Devices, Stepper Motors, and Servo Motor. Selection of Actuators.	04
4. 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. Timer instructions ON Delay, OFF Delay and Retentive Timers-UP Counter, DOWN Counter and UP down Counters,	06
5. SCADA and HMI	Introduction of SCADA, Features of SCADA, Applications of SCADA,	03



	Networking of PLC and SCADA (Any One Protocol). Introduction to HMI, Introduction of DCS.	
6.	Microcontroller and Microprocessor- Introduction, Comparison of Microcontroller and Microprocessor, Architecture – Pin configuration of 8051 Microcontroller, Assembly programming Operational amplifier circuits, filtering circuits, Analog, and Digital signal conversion. Signal Conditioning: Operational amplifier circuits, filtering circuits, Analog, and Digital signal conversion.	05

References:

Textbooks:

- Herbert Schildt and Dale Skrien, "Java Fundamentals – A comprehensive Introduction", McGraw Hill.
- Herbert Schildt, "Java the complete reference", McGraw Hill, Osborne.
- Charles Dierbach, "Introduction to Computer Science Using Python", Wiley India
- Reema Thareja, "Python Programming using problem solving approach", Oxford University press

Reference Books:

- Introduction to Mechatronics & Measurement System, David G. Alciatore, Michael B. Histan, McGraw Hill Education.
- Programmable Logic Controllers, Petruzella Frank D, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- SCADA: Supervisory Control and Data Acquisition, Stuart A. Boyer ISA Publication.
- Programmable Logic Controllers, Bolton 4th Edition, 2015



Class: T. Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3644	Course Name: Software Training Lab-II :ABAQUS	--	--	2	1

Course Description:

Mechanical Engineers with excellent analytical and critical skills are capable to extract the realistic behavior of a component, system or a process. They rely on simulation tools for analyzing, designing, optimizing the products. Thorough knowledge of finite element method principles and supplemented with hands on experience of analysis software enhances the ability of mechanical engineers to innovate the new products which are economically viable and environmentally sustainable.

Course Learning Outcomes:

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

1. Analyse the component from structural and thermal perspective and comment on the feasibility of obtained solutions.
2. Compare the results of ABAQUS with other approaches like analytical and experimental results.

Prerequisite:

Fundamentals of Strength of Material, Design of Machine components, Heat Transfer and Finite Element Method.

Course Content		
Expt. No.	Description	Hrs.
1.	Hand calculation of one-dimensional truss analysis and comparing the results with ABAQUS.	02
2.	Introduction to ABAQUS environment, file handling, preprocessing and post-processing.	02
3.	Two-dimensional truss analysis of overhead hoist structure subjected to concentrated load.	02
4.	Structural analysis of a beam subjected to point load and uniformly distributed load. Comparing the deflections of ABAQUS and analytical results.	02
5.	Structural analysis of steel bar with structural and thermal load for the given boundary condition in stepped bar.	02
6.	Structural analysis of plate with a hole and determining stress concentration.	02
7.	Thermal analysis of 1D and 2D slab, and plot the variation of temperature along the thickness of slab.	02
8.	Structural analysis of three-dimensional bracket subjected to surface traction load at the hole.	02
9.	Modal and Dynamic analysis of structural frame	04
10.	Intended to undertake a Mini Project which demonstrate the ability to validate the results of ABAQUS with other approaches.	04



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

References:

Text Books:

- ABAQUS 6.12, Complete Analysis online manual Vol. 2.
- www.tutorialspoint.com (ABAQUS online tutorials)

Reference Books:

- BM Asghar, Finite Element Analysis of structure, John Willey and Sons.





K.E. Society's
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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3644	Course Name: Software Training Lab-II : HyperMesh	--	--	2	1

Course Description:

This laboratory course is offered at the VII semester of B. Tech. (Mechanical) program. Mechanical Engineers rely heavily on computers as a tool to design equipment, analyze flow patterns, predict energy transfers, establish stress and strain patterns and to control machines and processes. The great strides in space exploration, spacecraft design, power station design, the many innovations in travel and agriculture all trace their success to the importance of Engineers being able to simulate and solve complex problems on computers. Clearly, the current and future Mechanical Engineering practitioner must be highly computer literate. The demand for Mechanical Engineer with computer competency with simulation and analysis software is very high. This course provides training on following simulation and analysis software. Students are required choose any one of them:

1. ABAQUS
2. HyperMesh
3. Computational Fluid Dynamics
4. ANSYS

Course Learning Outcomes:

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

1. Use simulation and analysis software in Mechanical Engineering.
2. Develop solution for the Mechanical Engineering problems using simulation and analysis software.

Prerequisite:

Students should have fundamental knowledge of Applied Mechanics, Strength of Materials, Heat Transfer, Design and Finite Element Analysis

Course Content		
Experiment No	Description	Hrs
1.	Introduction to CAE	02
2.	Introduction to Meshing-Need of mesh, Types of Mesh etc.	02
3.	1D Meshing- Rod, Bar, Beam	02
4.	1D analysis with Bar and Beam problem	02
5	Case study: Roll Cage Analysis	02
6	Geometry and Geometry cleanup in HyperMesh – Create, edit, import.	02
7.	2D Meshing- introduction, Types of elements, Mesh process	02
8.	Static analysis of late with hole with 2D mesh	02





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

9	3D Meshing- introduction, Types of elements, Mesh process	04
10.	Generation of tetra Mesh using	04

References:

Text Books:

- Nikhil S. Gokhale, Practical Finite Element Analysis, Finite to infinite.

Reference Books:

- David V. Hutton, Fundamentals of Finite Element Analysis, McGraw Hill.





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Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3644	Course Name: Software Training Lab-II :Computational Fluid Dynamics	--	--	2	1

Course Description:

The CFD lab course is in the context of a useful design tool for industry and a vital research tool for thermo-fluid research across many disciplines. To develop students' understanding of the conservation laws applied to fluid motion and heat transfer. Familiarize students with basic computational methods including explicit, implicit methods, discretization schemes and stability analysis. Familiarize students with the basic steps and terminology associated with CFD. To develop practical expertise of solving CFD problems with a commercial. CFD code, ANSYS. To develop an awareness of the power and of limitations of CFD

Course Outcomes:

At the end of the course the students will be able to,

1. Formulate problems in fluid flow and heat transfer.
2. Apply initial and boundary conditions to solve heat transfer problems.
3. Use ANSYS-Fluent for solving real life engineering problems

Prerequisite: Students must have the knowledge of programming language C++ or MATLAB, Heat Transfer, Fluid Dynamics

Course Content		
Experiment No	Description	Hrs
1.	Temperature distribution on plate	02
2.	Flow over cylinder	02
3.	Flow in mixing T.	02
4.	Flow through a butterfly valve	02
5.	Flow through an automatic catalytic converter.	02
6.	External flow over Ahmed body	02
7.	Flow in an axial rotor /stator arrangement	02
8.	Transient analysis of Square plate	02
9.	Cooling of electronic component with convection and radiation	02
10.	Flow from a circular vent.	02
11.	Multiphase flow in mixing vessel.(VOF)	02
12.	Supersonic flow in a Laval nozzle.	02



References:

Text Books:

- ANSYS Fluent user Manual

Reference Books:

- Computational Fluid Dynamics: J. D. Anderson, The Basics with Applications, McGraw Hill.
- Computational Fluid Flow and Heat Transfer, K. Muralidhar and T. Sundararajan, Second Edition, Narosa Publishing House.
- Computational Fluid Dynamics for Engineers - Volume 1, K. A. Ho_mann, S. T. Chiang, Engineering Education System.
- Essential Computational Fluid Dynamics, O. Zikanov, Wiley India.
- Versteeg, H. K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics
- The Finite Volume Method, Pearson
- Computational Fluid Dynamics: A Practical Approach, J. Tu, G. H. Yeoh and C. Liu, Butterworth Heinemann (Indian Edition).
- Numerical Heat Transfer and Fluid Flow, S. V. Patankar, Taylor and Francis (Indian Edition).
- Introduction to Computational Fluid Dynamics, A. W. Date, Cambridge (Indian Edition).





K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3644	Course Name: Software Training Lab-II : ANSYS	--	--	2	1

Course Description:

The Software Training Lab-II course provides a comprehensive exploration of Finite Element Analysis (FEA) methodologies, beginning with an overview of the FEA approach and an introduction to ANSYS-APDL software. The focus then shifts to the crucial aspect of discretization, covering meshing techniques, types of elements, and the selection criteria for elements, including mapped and automatic meshing. Students delve into practical applications through static structural analyses of 1D stepped bars, trusses, and beams, comparing results with FEM for validation. The course further extends into stress analysis of plates with circular holes under static loads, static structural analysis of steel brackets, thermal analysis of 1D components, and transient structural analysis for 1D or 2D components. Finally, the syllabus concludes with an exploration of buckling analysis for columns, offering a well-rounded understanding of ANSYS capabilities across various engineering scenarios.

Course Learning Outcomes:

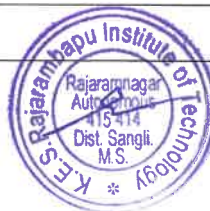
After successful completion of the course, students will be able to,

1. Apply finite element method to solve problems in solid mechanics and heat transfer.
2. Formulate and solve problems in one dimensional structure including trusses, beams and frames.
3. Choose proper element as per the application

Prerequisite:

Students must have the knowledge of Mechanics of Solids, Engineering Mechanics, Finite Element Method.

Course Content		
Unit No	Description	Hrs.
1.	Overview of Finite Element Analysis (FEA) approach, overview of FEA software packages, introduction to ANSYS-APDL.	02
2.	Discretization: Meshing, Types of Elements, Choice of Elements, Mapped, Automatic Meshing.	02
3.	Static structural analysis of 1D stepped bar and comparison of software results with FEM.	02
4.	Static structural analysis of truss.	02
5.	Static structural analysis of beam and comparison of software results with FEM.	02
6.	Stress analysis of plate with circular Hole under static load.	02
7.	Static structural analysis steel bracket	02
8.	Thermal analysis of 1D component	02





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Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

9.	Transient Structural analysis for 1D or 2D components.	04
10	Buckling analysis of columns.	04

References:

Text Books:

- Bathe, K.J. Finite Element Procedures. Prentice Hall.
- Chandrupatla, Tirupathi R., and Ashok D. Belegundu. Introduction to Finite Elements in Engineering. New Jersey: Prentice Hall.

Reference Books:

- Gokhale, Nitin S. Practical Finite Element Analysis. Finite to Infinite.
- P. Seshu, Finite Element Analysis, PHI publication.
- Law, C. Y. Introduction to ANSYS Parametric Design Language (APDL): A Guide to the ANSYS Command Language. SDC Publications.



Class: T.Y. B. Tech Mech	Semester: VI	L	T	P	Credits
Course Code: ME3664	Course Name: Applied Thermal Engineering Lab	--	--	2	1

Course Description:

Mechanical engineering deals with conversion of one form of energy in to other useful form. Conversion of Fluid energy in to Mech. energy & mechanical energy in to fluid energy plays important role, which is the scope of this course. Study of these machines, selection of these machines for particular applications is content of syllabus.

Course Learning Outcomes:

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

1. Explain the various thermodynamic process of thermal systems
2. Perform the experimentation of thermal systems
3. Analyse the performance of thermal systems

Prerequisite:

Students should know Concept of energy, work, heat and conversion between them. Engineering thermodynamics, fluid mechanics

Course Content		
Unit No.	Description	Hrs
1.	Perform Dismantling and Assembly of IC Engine	02
2.	Estimate the calorific value of given fuel	02
3.	Prepare the Heat Balance Sheet of the IC Engine	02
4.	Calculate the COP of Refrigeration Bench	02
5.	Calculate the COP Cascade system	02
6.	Examine the performance of Ice plant	02
7.	Determine the performance of Steam boiler	02
8.	Estimate the performance Steam turbine	02
9.	Determine the performance Steam condenser	02
10.	Demonstration of vapour compression cycle fault analysis rig.	02
11.	Demonstration of refrigeration defrosting chamber.	02
12.	Industry Visits	02

References:



Text Books: -

- V. Ganeshan, Internal Combustion Engines, 4, Mc Graw Hill
- M. L. Mathur, R. P. Sharma, Internal Combustion Engine, 8, Dhanpat Rai Publications
- Arora Domkundwar, Refrigeration and Air Conditioning, Dhanpatrai and sons Publications.
- R. S. Khurmi, Refrigeration and Air Conditioning, S. Chand Publications.
- R. K. Rajput, Thermal Engineering, Laxmi Publications, Delhi
- R. Yadav, Steam & Gas Turbines, CPH Allahabad.
- B. K. Sarkar, Thermal Engineering, Tata McGraw Hill.

Reference Books: -

- V.P. Vasandani, Hydraulic Machines, Khanna Publishers
- N.S. Govindrao, Fluid flow machines, Tata McGraw Hill.
- S.M. Yahya, Turbo machines, Satya Prakashan, Delhi.
- P.L. Balleny, Thermal Eng., Khanna Publishers, Delhi.
- Modi and Seth, Fluid Mechanics and Hydraulic Machines, Standard Book House, Delhi.
- Mahesh M. Rathore, Thermal Engineering, McGraw Hill.

Data Book:

- S. C. Jain, Steam Tables, Birla Publications Pvt. Ltd. Delhi.



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

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 like 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	3
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.	2
3.	Boat & Streams Upstream case, Downstream case, Perpendicular movement	2
4.	Races Head Start, Dead heat, defeat, 3 man participating in race, ratio related examples,	2
5.	Permutation & Combination Difference between P & C, Theorems of Permutation Theorems of Combination, Counting numbers of squares & rectangles, Triangle.	2
6.	Probability	2

	Introduction, Range of Probability, Sum & Product Rule, Coins, Dice, Cards, Bags & Balls	
7.	Geometry Triangles, Quadrilaterals, Circles, Polygons.	2
8.	Mensuration Cube, Cuboid, Cylinder, Cone Sphere, Prism.	2
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.	2
10.	Calendar Leap year, odd day concept, Month code, century codes, Same Calendar concept, Finding day or date. (Box method)	2
11.	Seating Arrangement Type of arrangements, Types of information, Data extraction, Linear-Non-Linear movement, Advance movement.	2
12.	Analytical Reasoning I Figure Counting, Pattern Completion / Figure Matrix, Embedded Figures / Hidden Figures	3
13.	Analytical Reasoning II Water images, Mirror Images, Cubes and Dice, Paper Folding and Cutting.	2
14.	Statements & Conclusion Understanding the Premise, Identifying Logical Deductions, Cause and Effect.	2

References:

- R. S. Aggarwal, "Quantitative Aptitude", S Chand Publishing, New Delhi.
- R. S. Aggarwal, "Logical Reasoning", S Chand Publishing, New Delhi.
- Arun Sharma, "Quantitative Aptitude", McGraw Hill Publishing, New Delhi.
- Arun Sharma, "Logical Reasoning", McGraw Hill Publishing, New Delhi.



K.E. Society's
Rajarambapu Institute of Technology, Rajaramnagar
(An Autonomous Institute, affiliated to Shivaji University, Kolhapur)
Curriculum Structure and Evaluation Scheme
To be implemented for 2023-27 Batch
Department of Mechanical Engineering

Class: T.Y. B. Tech Mech	Semester: VI
Course Code: ME3764	Course Name: Capstone project Phase I

L	T	P	Credits
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Course Description:

A capstone project is designed to encourage the students to think critically, solve challenging problems, and develop skills such as communication, research, teamwork, project management and planning, self-sufficiency, goal setting, etc. In most cases, the projects are also interdisciplinary, in the sense that students must apply skills or investigate issues across many different subject areas or domains of knowledge. Capstone projects also tend to encourage students to connect their projects to community issues or problems and to integrate outside-of-school learning experiences. Ultimately, a capstone project represents new work and ideas, allowing students to demonstrate the knowledge and skills they have gained during past academic years. The students in a group of not more than four will work under the project supervisor's guidance on the project they undertake.

The objective is to prepare the students to examine any design, process, or phenomenon from all angles, encourage independent thinking and working, and expose them to industry. Also, it allows students to integrate and apply knowledge from different mechanical engineering disciplines to conduct an open-ended engineering project requiring team collaboration.

Course Learning Outcomes:

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

1. Convert an open-ended problem statement into a statement of work or a set of design specifications
2. Identify the literature gap by conducting a survey of several available literature in the preferred field of study.
3. Decompose the problem/task into subtasks, prioritizes subtasks, and establish a timetable and milestones by which progress may be evaluated.
4. Select and apply the appropriate design of experiments, experimental setup, models, or simulation technique for the project task.
5. Collaborates with team members of diverse backgrounds and perspectives to achieve a common goal.
6. Produce usable documents of record regarding the design process and design state and communicate effectively.

Prerequisite:

1. In-depth understanding of all the subjects learned so far.
2. Two weeks of in-plant training must be completed.



Course Content:

The project work may consist of,

1. To search and select an appropriate topic for capstone project work considering innovations, new products, and solutions to long-standing problems.
2. A comprehensive and up-to-date survey of literature related to the study of a phenomenon or product.
3. Prepare and refine the project proposal to the point where the student should demonstrate that it is worthy of the undertaking and will be completed in time.
4. Prepare a well-defined project plan with a budget linked to project activities and outcomes.
5. Apply appropriate methodology to solve critical engineering problems.
6. Design and development of equipment, components, and test setup.
7. Conduct experiments, test products and processes for various parameters, and interpret the results.
8. Write the technical report of work completed in phase I.

Students should complete following work during Semester: VII

Literature survey, problem identification, synopsis preparation, Project blueprint

Course Assessment-

Projects will be evaluated using Rubrics that assess

- Proposal of project work completed in all aspects
- Project proposal presentation
- Interim progress presented during phase – I
- The written report for phase -I
- The oral presentation for part-I

Each student's performance will be assessed individually with the team's overall performance by the supervisor, group chairman, and committee using the rubrics provided in appendices. The project committee should consist of at least four academic staff with a project supervisor. The average scores of all supervisors for each rubric are combined using the following percentages to get a weighted average grade point.

Synopsis Proposal Rubrics - 50%

Interim Progress Assessment Rubrics - 50%

