ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM

B.E. INDUSTRIAL ENGINEERING

PROGRAM EDUCATIONAL COURSE OBJECTIVES (PEOs)

I.	Toprovidethestudentsasolidfoundationinmathematical, scientific and engineering knowledge required to comprehend, analyze, design and develop innovative solutions for realtimeproblems.
II.	To impart the students a spirit of team work, effective communication and a commitment to professional ethics.
III.	To imbibe the students with a desire for lifelong learning and successful career with professional excellence.
IV.	To create and maintain an ambience for Industry – Institute Collaborations.

PROGRAM COURSE OUTCOMES (POs)

PO#	**Graduate Attribute**
1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	**Problem analysis:** Identify, formulate, review research literature,and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, andengineeringsciences.
3	**Design/developmentof solutions:** Design solutions for complex engineering problems and design systemcomponentsor processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.
4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issuesand the consequent responsibilitiesrelevant to the professional engineering practice.
7	**Environmentand sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independentand life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC COURSE OUTCOMES (PSOs)

On successful completion of the Industrial Engineering Degree programme, the Graduates shallexhibitthefollowing:

1.	Apply the knowledge gained inIndustrial Engineering for design and development of systems.
2.	Apply the knowledge acquired to investigate research oriented problems in Industrial engineering with due consideration for sustainability and social impacts.
3.	Use the engineering analysis and data management tools for effective management of multidisciplinary projects.

PEO's – PO's& PSO's MAPPING:

PEO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I.	3	3	3	2	1	2	2	1	2	1	1	2	3	3	2
II.	2	2	2	2	2	2	2	3	3	3	1	2	3	3	2
III.	3	3	2	2	2	3	2	2	2	2	2	3	3	2	2
IV.	2	2	2	2	2	2	2	3	2	2	2	3	2	2	2

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CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	**அறிவியல் தமிழ் /Scientific Thoughts in Tamil**	HSMC	1	0	0	1	1
PRACTICAL								
7	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
9	GE3172	English Laboratory $		0	0	2	2	1
			TOTAL	**16**	**1**	**10**	**27**	**22**

$ Skill Based Course

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH3251	Materials Science	BSC	3	0	0	3	3
4.	BE3251	Basic Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.		NCC Credit Course Level 1[#]	-	2	0	0	2	2
7.	GE3252	**தமிழர் மரபு / Heritage of Tamils**	HSMC	1	0	0	1	1
PRACTICAL								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3271	Basic Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language [$]	EEC	0	0	4	4	2
			TOTAL	**14**	**1**	**16**	**31**	**23**

[#] NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
[$] Skill Based Course

SEMESTER III

S. No.	Course Code	Course Title	Cate-Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MA3352	Probability and Linear Algebra	BSC	3	1	0	4	4
2.	CE3391	Fluid Mechanics and Machinery	ESC	3	1	0	4	4
3.	CE3491	Strength of Materials	ESC	3	0	0	3	3
4.	IE3351	Work System Design	PCC	3	0	0	3	3
5.	ME3393	Manufacturing Processes	PCC	3	0	0	3	3
6.	ME3351	Engineering Mechanics	ESC	3	0	0	3	3
PRACTICAL								
7.	CE3481	Strength of Materials and Fluid Machinery Laboratory	PCC	0	0	4	4	2
8.	ME3382	Manufacturing Technology Laboratory	PCC	0	0	4	4	2
9.	GE3361	Professional Development[$]	EEC	0	0	2	2	1
			TOTAL	**18**	**2**	**10**	**30**	**25**

[$] **Skill Based Course**

SEMESTER IV

S. No.	Course Code	Course Title	Cate-Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	IE3491	Operations Research	PCC	3	0	0	3	3
2.	IE3451	Thermodynamics	PCC	3	1	0	4	4
3.	IE3452	Applied Ergonomics	PCC	4	0	0	4	4
4.	IE3453	Engineering Quality Control	PCC	3	0	0	3	3
5.	AE3491	Mechanics of Machines	PCC	3	0	0	3	3
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
7.		NCC Credit Course Level 2[#]		3	0	0	3	0
PRACTICAL								
8.	IE3411	Work System Design Laboratory	PCC	0	0	3	3	1.5
9.	IE3461	Optimization Laboratory	PCC	0	0	3	3	1.5
			TOTAL	**18**	**1**	**6**	**25**	**22**

[#] **NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.**

SEMESTER V

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	IE3551	Production and Operations Management	PCC	3	0	0	3	3
2.	CPR333	Machine Design	PCC	-	-	-	-	3
3.		Professional Elective I	PEC	-	-	-	-	3
4.		Professional Elective II	PEC	-	-	-	-	3
5.		Professional Elective III	PEC	-	-	-	-	3
6.		Professional Elective IV	PEC	-	-	-	-	3
7.		Mandatory Course-I[&]	MC	3	0	0	3	0
PRACTICAL								
8.	IE3561	Ergonomics Laboratory	PCC	0	0	2	2	1
9.	ME3381	Computer Aided Machine Drawing	PCC	0	0	4	4	2
TOTAL				-	-	-	-	**21**

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MCI)

SEMESTER VI

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L		P		
THEORY								
1.	IE3651	Manufacturing Automation	PCC	3	0	0	3	3
2.		Open Elective – I*	OEC	3	0	0	3	3
3.		Professional Elective V	PEC	-	-	-	-	3
4.		Professional Elective VI	PEC	-	-	-	-	3
5.		Professional Elective VII	PEC	-	-	-	-	3
6.		Professional Elective VIII	PEC	-	-	-	-	3
7.		Mandatory Course-II[&]	MC	3	0	0	3	0
8.		NCC Credit Course Level 3[#]		3	0	0	3	3
PRACTICAL								
9.	IE3661	Automation Laboratory	PCC	0	0	2	2	1
			TOTAL	-	-	-	-	**19**

***Open Elective – I shall be chosen from the emerging technologies.**

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MCII)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER VII/VIII*

S. No.	Course Code	Course title	Cate Gory	Periods Per week			Total Contact periods	Credits
				L	T	P		
THEORY								
1.	IE3791	Simulation Modeling and Analysis	PCC	3	0	0	3	3
2.	IE3792	Supply Chain Management	PCC	3	0	0	3	3
3.	GE3751	Human Values and Ethics	HSMC	3	0	0	3	3
4.		Elective – Management #	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
PRACTICAL								
8.	IE3781	Systems Simulation Laboratory	PCC	0	0	2	2	1
			TOTAL	**21**	**0**	**2**	**23**	**22**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

****Open Elective – II shall be chosen from the emerging technologies.**

*****Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes).**

 # Elective - Management shall be chosen from the elective Management courses

SEMESTER VIII / VII*

S. No.	Course code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
PRACTICAL								
1.	IE3811	Project Work / Internship	EEC	0	0	20	20	**10**
			TOTAL	**0**	**0**	**20**	**20**	**10**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII**

TOTAL CREDITS: 164

MANDATORY COURSES I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

ELECTIVE - MANAGEMENT COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3752	Principles of Management	HSMC	3	0	0	3	3
2.	GE3753	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3754	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3755	Human Resource Management	HSMC	3	0	0	3	3
5.	GE3756	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3757	Industrial Management	HSMC	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES:VERTICALS								
Vertical 1	**Vertical 2**	**Vertical 3**	**Vertical 4**	**Vertical 5**	**Vertical 6**	**Vertical 7**	**Vertical 8**	**Vertical 9**
Operations and Supply Chain Management	Manufacturing System	Quality Systems	Software Quality Engineering	Robotics and Automation	Product and Process Development	Digital and Green Manufacturing	Diversified Courses Group 1	Diversified Courses Group 2
Project Management	Systems Engineering	Metrology and Measurements	Data Base Management Systems	Sensors and Instrumentation	Value Engineering	Digital Manufacturing and IoT	Materials Management	Entrepreneurship Development
Product Design and Value Engineering	Computer Integrated Manufacturing	Quality Assurance and Auditing	Design and Analysis of Algorithms	Electrical Drives and Actuators	Additive Manufacturing	Lean Manufacturing	Computational Methods and Algorithms	Decision Support and Intelligent Systems
Facility Design	Flexible Manufacturing Systems	Maintenance Engineering	Software Cost Estimation	Embedded Systems and Programming	CAD/CAM	Modern Robotics	Management Accounting and Financial Management	Automotive Systems
Business Process Re-engineering	Lean and Agile Manufacturing	Design of Experiments	Agile Software Development	Robotics	Design For X	Green Manufacturing Design and Practices	Robotics Engineering	Software Engineering and Methodologies
Enterprise Resource Planning	Operations Scheduling	Reliability Engineering	Software Quality Management	Smart mobility and Intelligent Vehicles	Ergonomics in Design	Environment Sustainability and Impact Assessment	Design Thinking and Innovation	Safety Engineering and Management
Cost Estimation and Control	Modelling of Manufacturing Systems	Advanced Measurement System	Software Testing	Haptics and Immersive Technologies	New Product Development	Energy Saving Machinery and Components	Productivity Management and Re-engineering	Principles of Computer Integrated Manufacturing Systems
Supply Chain Risk Management	Advanced Optimization Techniques	Lean Six Sigma	Software Metrics and Quality Audit	Drone Technologies	Product Life Cycle Management	Green Supply Chain Management	Applied Soft Computing	Cloud Computing
Logistics Management	-	Multivariate Data Analysis	Business Data Analytics	-	-	-	Nontraditional Manufacturing	Industry 4.0

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.
The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

Total number of courses per vertical may change as 6 or 7 or 8. If there is shortage of courses in a vertical then necessary courses may be chosen from another vertical of the same programme.

PROFESSIONAL ELECTIVE COURSES:VERTICALS

VERTICAL 1: OPERATIONS AND SUPPLY CHAIN MANAGEMENT

Sl. No.	Course code	Course Title	Category	Periods Perweek			Total Contact Periods	Credits
				L	T	P		
1.	CIE331	Project Management	PEC	3	0	0	3	3
2.	CIE332	Product Design and Value Engineering	PEC	3	0	0	3	3
3.	CIE333	Facility Design	PEC	3	0	0	3	3
4.	CIE334	Business Process Re-engineering	PEC	3	0	0	3	3
5.	CIE335	Enterprise Resource Planning	PEC	3	0	0	3	3
6.	CIE336	Cost Estimation and Control	PEC	3	0	0	3	3
7.	CIE337	Supply Chain Risk Management	PEC	3	0	0	3	3
8.	CIE338	Logistics Management	PEC	3	0	0	3	3

VERTICAL 2: MANUFACTURING SYSTEMS

Sl. No.	Course code	Coursetitle	Category	Periods Perweek			Total Contact Periods	Credits
				L	T	P		
1.	CIE339	Systems Engineering	PEC	3	0	0	3	3
2.	ME3792	Computer Integrated Manufacturing	PEC	3	0	0	3	3
3.	CIE340	Flexible Manufacturing Systems	PEC	3	0	0	3	3
4.	CIE341	Lean and Agile Manufacturing	PEC	3	0	0	3	3
5.	CIE342	Operations Scheduling	PEC	3	0	0	3	3
6.	CIE343	Modelling of Manufacturing Systems	PEC	3	0	0	3	3
7.	CIE344	Advanced Optimization Techniques	PEC	3	0	0	3	3

VERTICAL 3: QUALITY SYSTEMS

Sl. No.	Course code	Coursetitle	Category	Periods Perweek			Total Contact Periods	Credits
				L	T	P		
1.	ME3592	Metrology and Measurements	PEC	3	0	0	3	3
2.	CIE345	Quality Assurance and Auditing	PEC	3	0	0	3	3
3.	CIE346	Maintenance Engineering	PEC	3	0	0	3	3
4.	CIE347	Design of Experiments	PEC	3	0	0	3	3
5.	CIE348	Reliability Engineering	PEC	3	0	0	3	3
6.	CIE349	Advanced Measurement System	PEC	3	0	0	3	3
7.	CIE350	Lean Six Sigma	PEC	3	0	0	3	3
8.	CIE351	Multivariate Data Analysis	PEC	3	0	0	3	3

VERTICAL 4: SOFTWARE QUALITY ENGINEERING

SL. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CCS384	Database Management Systems	PEC	3	0	0	3	3
2.	CIE352	Design and Analysis of Algorithms	PEC	3	0	0	3	3
3.	CIE353	Software Cost Estimation	PEC	3	0	0	3	3
4.	CIE354	Agile Software Development	PEC	3	0	0	3	3
5.	CIE355	Software Quality Management	PEC	3	0	0	3	3
6.	CIE356	Software Testing	PEC	3	0	0	3	3
7.	CIE357	Software Metrics and Quality Audit	PEC	3	0	0	3	3
8.	CIE358	Business Data Analytics	PEC	3	0	0	3	3

VERTICAL 5: ROBOTICS AND AUTOMATION

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIOD	CREDITS
				L	T	P		
1.	MR3491	Sensors and Instrumentation	PEC	3	0	0	3	3
2.	MR3392	Electrical Drives and Actuators	PEC	3	0	0	3	3
3.	MR3492	Embedded Systems and Programming	PEC	3	0	0	3	3
4.	MR3691	Robotics	PEC	3	0	0	3	3
5.	CMR338	Smart mobility and Intelligent Vehicles	PEC	3	0	0	3	3
6.	CME345	Haptics and Immersive Technologies	PEC	3	0	0	3	3
7.	CRA332	Drone Technologies	PEC	3	0	0	3	3

VERTICAL 6: PRODUCT AND PROCESS DEVELOPMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIOD	CREDITS
				L	T	P		
1.	CME338	Value Engineering	PEC	3	0	0	3	3
2.	CME339	Additive Manufacturing	PEC	2	0	2	4	3
3.	CME340	CAD/CAM	PEC	3	0	0	3	3
4.	CME341	Design For X	PEC	3	0	0	3	3
5.	CME342	Ergonomics in Design	PEC	3	0	0	3	3
6.	CME343	New Product Development	PEC	3	0	0	3	3
7.	CME344	Product Life Cycle Management	PEC	3	0	0	3	3

VERTICAL 7: DIGITAL AND GREEN MANUFACTURING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIOD	CREDITS
				L	T	P		
1.	CME346	Digital Manufacturing and IoT	PEC	2	0	2	4	3
2.	CME347	Lean Manufacturing	PEC	3	0	0	3	3
3.	CME348	Modern Robotics	PEC	2	0	2	4	3
4.	CME349	Green Manufacturing Design and Practices	PEC	3	0	0	3	3
5.	CME350	Environment Sustainability and Impact Assessment	PEC	3	0	0	3	3
6.	CME351	Energy Saving Machinery and Components	PEC	3	0	0	3	3
7.	CME352	Green Supply Chain Management	PEC	3	0	0	3	3

VERTICAL 8: DIVERSIFIED COURSES GROUP 1

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IE3001	Materials Management	PEC	3	0	0	3	3
2.	IE3002	Computational Methods and Algorithms	PEC	3	0	0	3	3
3.	CIE359	Management Accounting and Financial Management	PEC	3	0	0	3	3
4.	IE3003	Robotics Engineering	PEC	3	0	0	3	3
5.	CIE360	Design Thinking and Innovation	PEC	3	0	0	3	3
6.	CIE361	Productivity Management and Re-engineering	PEC	3	0	0	3	3
7.	IE3004	Applied Soft Computing	PEC	3	0	0	3	3
8.	IE3005	Nontraditional Manufacturing	PEC	3	0	0	3	3

VERTICAL 9: DIVERSIFIED COURSES GROUP 2

Sl. No.	Course Code	Course Title	Category	Periods Perweek			Total Contact periods	Credits
				L	T	P		
1.	CIE362	Entrepreneurship Development	PEC	3	0	0	3	3
2.	CIE363	Decision Support and Intelligent Systems	PEC	3	0	0	3	3
3.	IE3006	Automotive Systems	PEC	3	0	0	3	3
4.	IE3007	Software Engineering and Methodologies	PEC	3	0	0	3	3
5.	CIE364	Safety Engineering and Management	PEC	3	0	0	3	3
6.	IE3008	Principles of Computer Integrated Manufacturing Systems	PEC	3	0	0	3	3
7.	IE3009	Cloud Computing	PEC	3	0	0	3	3
8.	CMF340	Industry 4.0	PEC	3	0	0	3	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.)

OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
3.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3

4.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
5.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
6.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
7.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
8.	OMF353	Sustainable Manufacturing	OEC	3	0	0	3	3
9.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
10.	OAS352	Space Engineering	OEC	3	0	0	3	3
11.	OIM351	Industrial Management	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3
21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3
25.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
26.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
27.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
28.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
29.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
30.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
31.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3

32.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
33.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
34.	OEC351	Signals and Systems	OEC	3	0	0	3	3
35.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
36.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
37.	OBM352	Assistive Technology	OEC	3	0	0	3	3
38.	OMA352	Operations Research	OEC	3	0	0	3	3
39.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
40.	OMA354	Linear Algebra	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
3.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
4.	OMA356	Random Processes	OEC	3	0	0	3	3
5.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
6.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
7.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
8.	OME352	Additive Manufacturing	OEC	3	0	0	3	3
9.	OME353	New Product Development	OEC	3	0	0	3	3
10.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
11.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
12.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
13.	OAU352	Batteries and Management system	OEC	3	0	0	3	3
14.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3

15.	OAS353	Space Vehicles	OEC	3	0	0	3	3
16.	OIM352	Management Science	OEC	3	0	0	3	3
17.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
22.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Foundation of Automation	OEC	3	0	0	3	3
25.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
26.	OMV351	Marine Propulsion	OEC	3	0	0	3	3
27.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
28.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
29.	OAE353	Drone Technologies	OEC	3	0	0	3	3
30.	OGI352	Geographical Information System	OEC	3	0	0	3	3
31.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
32.	OEN352	Biodiversity Conservation	OEC	3	0	0	3	3
33.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
34.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
35.	OCH353	Energy Technology	OEC	3	0	0	3	3
36.	OCH354	Surface Science	OEC	3	0	0	3	3
37.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
38.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
39.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
40.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
41.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
42.	OTT355	Fibre Science	OEC	3	0	0	3	3
43.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
44.	OPE353	Industrial safety	OEC	3	0	0	3	3

45.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
46.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
47.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
48.	OEC353	VLSI Design	OEC	3	0	0	3	3
49.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
50.	OBM353	Wearable devices	OEC	3	0	0	3	3
51.	OBM354	Medical Informatics	OEC	3	0	0	3	3

SUMMARY

B.E. INDUSTRIAL ENGINEERING										
Sl.No.	**Subject Area**	**Credits per Semester**								**Credits Total**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII / VIII**	**VII / VIII**	
1.	HSMC	3	2					6		11
2.	BSC	12	7	4	2					25
3.	ESC	5	11	10						26
4.	PCC			10	20	9	4	7		50
5.	PEC					12	12			24
6.	OEC						3	9		12
7.	EEC	1	2	1					10	14
8.	Mandatory Course (Non credit)					✓	✓			
		21	22	25	22	21	19	22	10	
									Total	**162**

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

VERTICALS FOR MINOR DEGREE (In addition to the all the verticals of other programmes)

Vertical I Fintech and Block Chain	Vertical II Entrepreneurship	Vertical III Public Administration	Vertical IV Business Data Analytics	Vertical V Environmental and Sustainability
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics For Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Datamining For Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Marketing And Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation And Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics For Management	PEC	3	0	0	3	3
2.	CMG350	Datamining For Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing And Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation And Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENTAL AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

MA3352 PROBABILITY AND LINEAR ALGEBRA L T P C
3 1 0 4

COURSE OBJECTIVES:

- To introduce the basic notions of vector spaces which will then be used to solve related problems.
- To understand the concepts of vector space, linear transformations and diagonalization.
- To apply the concept of inner product spaces in orthogonalization.
- To provide necessary basics in probability and random processes that are relevant in applications such as random signals, linear systems in communication engineering.
- To understand the basic concepts of probability, one and two dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.

UNIT II TWO- DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III VECTOR SPACES 9+3

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions.

UNIT IV LINEAR TRANSFORMATION AND DIAGONALIZATION 9+3

Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Eigenvalues and eigenvectors –Diagonalization.

UNIT V INNER PRODUCT SPACES 9+3

Inner product, norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course, students should be able to:

CO1: Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.
CO2: Demonstrate accurate and efficient use of advanced algebraic techniques.
CO3: Demonstrate their mastery by solving non-trivial problems related to the concepts and by proving simple theorems about the statements proven by the text.
CO4: Understand the fundamental concepts of probability with a thorough knowledge of standard distributions that can describe certain real-life phenomenon.
CO5: Understand the basic concepts of one and two dimensional random variables and apply them to model engineering problems.

TEXT BOOKS

1. Johnson. R.A., Miller. I and Freund. J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. Friedberg. A.H., Insel. A.J. and Spence. L., "Linear Algebra", Prentice Hall of India, New Delhi, 4th Edition, 2004.

REFERENCE BOOKS

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
2. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Elsevier, 2014.
3. Spiegel. M.R., Schiller. J. and Srinivasan . R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
4. Kolman. B. Hill. D.R., "Introductory Linear Algebra", Pearson Education, New Delhi, First Reprint, 2009.
5. Kumaresan. S., "Linear Algebra – A Geometric Approach", Prentice – Hall of India, New Delhi, Reprint, 2010.
6. Strang. G., "Linear Algebra and its applications", Thomson (Brooks/Cole), New Delhi, 2005.

CE3391 FLUID MECHANICS AND MACHINERY **L T P C**
3 1 0 4

COURSE OBJECTIVE:

To introduce the students about properties of the fluids, behaviour of fluids under static conditions and to impart basic knowledge of the dynamics of fluids and to expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends with an exposure to the significance of boundary layer theory and its thicknesses. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10+3

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9+3

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 8+3

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV TURBINES 9+3

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

UNIT V PUMPS 9+3

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and its variations - Work saved by fitting air vessels - Rotary pumps.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of the course, the student is expected to be able to

CO1 Understand the properties and behaviour in static conditions. Also to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics

CO2 Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also to understand the concept of boundary layer and its thickness on the flat solid surface.

CO3 Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies

CO4 Explain the working principles of various turbines and design the various types of turbines

CO5 Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

TEXT BOOKS:

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, (2017)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2004.

REFERENCES:

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 1995.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
2. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
3. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
4. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

PO/PSO		Course Outcome					Overall Correlation of COs to POs
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences	3	3	3	3	3	3
PO2	Problem analysis	3	3	3	3	3	3
PO3	Design / development of solutions	2	3	3	3	3	3
PO4	Investigation	2	2	3	3	3	3
PO5	Modern Tool Usage	1	1	1	1	1	1
PO6	Engineer and Society	2	2	2	2	2	2
PO7	Environment and Sustainability	2	2	2	2	2	2
PO8	Ethics	1	1	1	1	1	1
PO9	Individual and Team work	2	2	2	2	2	2
PO10	Communication	1	1	1	1	1	1
PO11	Project Management and Finance	1	1	1	1	1	1
PO12	Life Long Learning	2	2	2	3	3	2
PSO1	Knowledge of Mechanical Engineering discipline	3	3	3	3	3	3
PSO2	Critical analysis of Mechanical Engineering problems and innovation	2	2	3	2	2	2
PSO3	Conceptualization and evaluation of engineering solutions to Mechanical Engineering Issues	3	3	3	2	2	3

CE3491 **STRENGTH OF MATERIALS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses - Deformation of simple and compound bars – Thermal stresses – Elastic constants - Volumertric strains – Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – Types - Transverse loading on beams – Shear force and Bending moment in beams – Cantilever, Simply supported and over hanging beams. Theory of simple bending – Bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Theory of Torsion – Stresses and Deformations in Solid and Hollow Circular Shafts – Combined bending moment and torsion of shafts - Power transmitted to shaft – Shaft in series and parallel – Closed and Open Coiled helical springs – springs in series and parallel.

UNIT IV DEFLECTION OF BEAMS 9

Elastic curve – Governing differential equation - Double integration method - Macaulay's method - Area moment method - Conjugate beam method for computation of slope and deflection of determinant beams.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses - Deformation in thin cylinders – Spherical shells subjected to internal pressure – Deformation in spherical shells – Thick cylinders - Lame's theory.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
2. Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
3. Apply basic equation of torsion in designing of shafts and helical springs
4. Calculate slope and deflection in beams using different methods.
5. Analyze thin and thick shells for applied pressures.

TEXT BOOKS:

1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018.
2. Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

REFERENCES:

1. Singh. D.K., “Strength of Materials”, Ane Books Pvt Ltd., New Delhi, 2021.
2. Egor P Popov, “Engineering Mechanics of Solids”, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Beer. F.P. & Johnston. E.R. “Mechanics of Materials”, Tata McGraw Hill, 8th Edition, New Delhi 2019.
4. Vazirani. V.N, Ratwani. M.M, Duggal .S.K “Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1”, Khanna Publishers, New Delhi 2014.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
2	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
3	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
4	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
5	3	3	3	3	2	3	1	3	2	3	1	3	3	2	3
Low (1) ; Medium (2) ; High (3)															

IE3351 WORK SYSTEM DESIGN **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- Explain the concepts of workstudy productivity and productivity measurement approaches.
- Plan and record and analyse selected tasks using different flow charts.
- Use method study to improve a task. Apply principles of motion economy to improve performance.
- Plan and conduct a time study to improve the efficiency of the system.
- Appraise the standard times to assess the office work condition.

UNITI PRODUCTIVITY **9**

Work Study and Productivity - Total time for a job or operation, total work content and in effective time, – Production and Productivity-Productivity and standard of living, Factors affecting Productivity, Productivity measurement Models. – procedure of work study

UNITII METHODS ENGINEERING **9**

Methods Engineering-Steps – Recording Tools and techniques - Design of work place layout-Motionstudy-micromotion study - therbligs – cyclegraph and chronocycle graph – simochart –Principles of motion economy.

UNITIII WORK MEASUREMENT **9**

Purpose of work measurement –Techniques of work measurement- Time study- Equipment -selecting and timing the job - performance rating –allowances – Standard time – setting timestandardforworkwith machines-learning effect

UNITIV APPLIED WORK MEASUREMENT **9**

Work sampling and Structured estimating – Group sampling Technique –predetermined time standards (PTS), types - use of time standard - Methods Time Measurement (MTM)-MOSTtechnique-Wageincentive plans.

UNITV WORK DESIGN FOR OFFICE WORK **9**

Method Study in office- Organization and methods(O&M) - Work measurement of office work-WorkAnalysistechniques applied tosupportstaff-Formdesign andcontrol.

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Ability to understand the concepts of work study productivity and productivity measurement approaches.
CO2: Ability to Record and analyze selected tasks using different flow charts.
CO3: Ability to apply method study to improve a task. Apply principles of motion economy to improve performance.
CO4: Ability to conduct a time study to improve the efficiency of the system.
CO5: Ability to Estimate the standard times to assess the office work condition.

TEXT BOOKS:

1. Barnes, R.M, "Motion and Time Study, Design and measurement of work", John Wiley sons(Asia), Seventh edition, 2003.
2. ILO, "Introduction to Work Study",Oxford and IBH publishing, 2008.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3														
2		2	3										2		
3		2	3											2	
4				3										1	
5				2										1	
AVg.	1.5	2	3	2.5									2	1.33	

ME3393 MANUFACTURING PROCESSES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To illustrate the working principles of various metal casting processes.
2. To learn and apply the working principles of various metal joining processes.
3. To analyse the working principles of bulk deformation of metals.
4. To learn the working principles of sheet metal forming process.
5. To study and practice the working principles of plastics molding.

UNIT – I METAL CASTING PROCESSES **9**

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure , gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting –- Defects in Sand casting process-remedies

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Oxy fuel welding – Filler and Flux materials-–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electro slag welding– Plasma arc welding –– Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding ,Weld defects – inspection &remedies – Brazing - soldering – Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff moulding.

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the principle of different metal casting processes.
2. Describe the various metal joining processes.
3. Illustrate the different bulk deformation processes.
4. Apply the various sheet metal forming process.
5. Apply suitable molding technique for manufacturing of plastics components.

TEXT BOOKS:

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India,4th Edition, 2013
2. P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition,2018.

REFERENCES:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. S. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008.
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Eligth Edition, Materials and Processes, in Manufacturing ,Eight Edition ,Prentice – Hall of India, 1997.
4. Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997
5. Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3		2			2	3	1	1	-	-	1	3	1	2
2	3		2			2	3	1	1	-	-	1	3	1	2
3	3		2			2	2	1	1	-	-	1	3	1	2
4	3		2			2	2	1	1	-	-	1	3	1	2
5	3		2		2	2	2	1	1	-	-	1	3	1	2
Low (1) ; Medium (2) ; High (3)															

ME3351 **ENGINEERING MECHANICS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To Learn the use scalar and vector analytical techniques for analyzing forces in statically determinate structures
2. To introduce the equilibrium of rigid bodies , vector methods and free body diagram
3. To study and understand the distributed forces, surface, loading on beam and intensity.
4. To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5. To develop basic dynamics concepts – force, momentum, work and energy.

UNIT I STATICS OF PARTICLES **9**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles - Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES **9**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III DISTRIBUTED FORCES **9**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION **9**

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

UNIT V DYNAMICS OF PARTICLES **9**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Illustrate the vector and scalar representation of forces and moments
2. Analyse the rigid body in equilibrium
3. Evaluate the properties of distributed forces
4. Determine the friction and the effects by the laws of friction
5. Calculate dynamic forces exerted in rigid body

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12thEdition, 2019.
2. Vela Murali, “Engineering Mechanics-Statics and Dynamics”, Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2	1	2							2	3	1	1
2	3	2	2	1	2							2	3	1	1
3	3	2	3	1	2							2	3	1	2
4	3	2	3	1	2							2	3	1	2
5	3	2	3	1	2							2	3	1	2
Low (1) ; Medium (2) ; High (3)															

CE3481 STRENGTH OF MATERIALS AND FLUID MACHINERY LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVE:

1. To study the mechanical properties of metals, wood and spring by testing in laboratory.
2. To verify the principles studied in fluid mechanics and machinery theory by performing experiments in laboratory.

UNIT – I STRENGTH OF MATERIALS **30**

LIST OF EXPERIMENTS

1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal (Rockwell and Brinell Hardness)
4. Compression test on helical spring
5. Deflection test on carriage spring

UNIT – II FLUID MECHANICS AND MACHINES LABORATORY **30**

LIST OF EXPERIMENTS

1. (a) Determination of coefficient of discharge of a venturimeter
   (b) Determination of friction factor for flow through pipes
2. (a) Determination of metacentric height
   (b) Determination of forces due to impact of jet on a fixed plate
3. Characteristics of centrifugal pumps
4. Characteristics of reciprocating pump
5. Characteristics of Pelton wheel turbine

TOTAL: 60 PERIODS

OUTCOMES: On completion of the course, the student is expected to be able to

1. Determine the tensile, torsion and hardness properties of metals by testing
2. Determine the stiffness properties of helical and carriage spring
3. Apply the conservation laws to determine the coefficient of discharge of a venturimeter and finding the friction factor of given pipe
4. Apply the fluid static and momentum principles to determine the metacentric height and forces due to impact of jet
5. Determine the performance characteristics of turbine, rotodynamic pump and positive displacement pump.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	3	3	1	1	1	3	1	1	2	2	2	1
2	3	2	1	3	3	1	1	1	3	1	1	2	3	2	1
3	3	3	2	3	2	1	1	1	3	1	1	2	3	2	1
Low (1) ; Medium (2) ; High (3)															

ME3382 MANUFACTURING TECHNOLOGY LABORATORY L T P C

0 0 4 2

COURSE OBJECTIVES:

1 To Selecting appropriate tools, equipment's and machines to complete a given job.

2 To Performing various welding process using GMAW and fabricating gears using gear making machines.

3 To Performing various machining process such as rolling, drawing, turning, shaping, drilling, milling and analyzing the defects in the cast and machined components.

LIST OF EXPERIMENTS

1. Fabricating simple structural shapes using Gas Metal Arc Welding machine.
2. Preparing green sand moulds with cast patterns.
3. Taper Turning and Eccentric Turning on circular parts using lathe machine.
4. Knurling, external and internal thread cutting on circular parts using lathe machine.
5. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
6. Drilling and Reaming using vertical drilling machine.
7. Milling contours on plates using vertical milling machine.
8. Cutting spur and helical gear using milling machine.
9. Generating gears using gear hobbing machine.
10. Generating gears using gear shaping machine.
11. Grinding components using cylindrical and centerless grinding machine.
12. Grinding components using surface grinding machine.
13. Cutting force calculation using dynamometer in milling machine
14. Cutting force calculation using dynamometer in lathe machine.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1.	Centre Lathes	7 Nos.
2.	Shaper	1 No.
3.	Horizontal Milling Machine	1 No.
4.	Vertical Milling Machine	1 No.
5.	Surface Grinding Machine	1 No.
6.	Cylindrical Grinding Machine	1 No.
7.	Radial Drilling Machine	1 No.
8.	Lathe Tool Dynamometer	1 No.
9.	Milling Tool Dynamometer	1 No.
10.	Gear Hobbing Machine	1 No.
11.	Gear Shaping Machine	1 No.
12.	Arc welding transformer with cables and holders	2 Nos.
13.	Oxygen and Acetylene gas cylinders, blow pipe and other welding outfit	1 No.
14.	Moulding table, Moulding equipments	2 Nos.

TOTAL:60 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Demonstrate the safety precautions exercised in the mechanical workshop and join two metals using GMAW.
2. The students able to make the work piece as per given shape and size using machining process such as rolling, drawing, turning, shaping, drilling and milling.
3. The students become make the gears using gear making machines and analyze the defects in the cast and machined components

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3						1		2			1	1	2	2
2	3						1		2			1	1	2	2
3	3						1		2			1	1	2	2
Low (1) ; Medium (2) ; High (3)															

IE3491 **OPERATIONS RESEARCH** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Provide knowledge of optimization techniques and approaches.
- Formulate a real-world problem as a mathematical programming model.
- Enable the students apply mathematical, computational and communication skills neededfor the practical utility of Operations Research.
- Knowledge to solve networking problems.
- Knowledge to solve various inventory problems.
- Gain knowledge on solving different waiting line models.

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method. Solutions to LPP using simplex algorithm – Two phase method – Big M method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Revised simplex method - primal dual relationships – Dual simplex algorithm – Sensitivity analysis– changes in RHS value – changes in Coefficient of constraint – Adding new constraint – Adding new variable.

UNIT III NETWORK ANALYSIS 9

Transportation problems: Northwest corner rule, least cost method, Vogel's approximation method- stepping stone method - MODI method – Unbalanced transportation – Assignment problem – Hungarian algorithm –Project Management CPM & PERT. Minimum spanning tree problem: Prim'salgorithm, Kruskal's algorithm - Shortest path problem: Dijkstra's algorithms, Floyds algorithm - maximal flow problem: Maximal-flow minimum cut theorem - Maximal flow algorithm

UNIT IV INVENTORY MODELS 9

Purchase model with no shortages – Manufacturing model with no shortages - Model with price breaks - Reorder point model - Probabilistic inventory model

UNIT V QUEUING THEORY 9

Queuing theory terminology – Single server, multi server- limited and unlimited queue capacity- limited and unlimited population –limited and infinite queue length.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Learned to translate a real-world problem, given in words, into a mathematical Formulation.
CO2: An understanding of the role of algorithmic thinking in the solution of operations researchproblems.
CO3: Be able to build and solve Transportation Models and Assignment Models, maximal flowproblem, minimum spanning tree and shortest path problem.
CO4: Able to handle issues in various Inventory models.
CO5: The students acquire capability in applying and using of queuing models for day today problem

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3		3	2									2	
2	3	2		3	2								3		3
3	2	3	3	3	3									2	
4	3	3	3	3	3								2		
5	3	3	3	2	3									1	2
AVg.	2.4	2.4	3	2.4	2.6								2.5	1.6	2.5

TEXT BOOKS:

1. Panneerselvam R, "Operations Research", PHI, 2009.
2. Srinivasan G., "Operations Research Principles and Applications", PHI, 2017.

REFERENCES:

1. Hamdy A Taha, "Operations Research – An Introduction", Pearson, 2017.
2. Philips, Ravindran and Solberg, "Operations Research principle and practise", John Wiley,2007.
3. Ronald L Rardin, "Optimisation in Operations Research", Pearson, 2018.

IE3451 THERMODYNAMICS L T P C
3 1 0 4

COURSE OBJECTIVES:

- To explain the basic concepts of thermodynamics and the first law of thermodynamics.
- To analyze the thermodynamics' second law.
- To assess the qualities of pure materials.
- To obtain a better understanding of mode of heat conduction, convection, and radiation.
- To apply thermodynamic concepts to IC engines, boilers, turbines, refrigeration, and air-conditioning systems.

UNIT I BASICS CONCEPTS AND FIRST LAW OF THERMODYNAMICS 9+3

Basic concepts; Continuum and macroscopic approach; thermodynamic systems (closed and open); thermodynamic properties and equilibrium; state of a system, state postulate for simple compressible substances, paths and processes on state diagrams; concepts of heat and work, different modes of work; zeroth law of thermodynamics; concept of temperature. First Law of Thermodynamics; Concept of energy and various forms of energy; internal energy, enthalpy; specific heats; first law applied to elementary processes, closed systems and control volumes, steady and unsteady flow analysis

UNIT II SECOND LAW OF THERMODYNAMICS 9+3

Second law of thermodynamics; Limitations of the first law of thermodynamics, concepts of heat engines and heat pumps/refrigerators, Kelvin-Planck and Clausius statements and their equivalence; reversible and irreversible processes; Carnot cycle and Carnot theorems; thermodynamic temperature scale; Clausius inequality and concept of entropy; the principle of increase of entropy, T-s diagrams; second law analysis of control volume; availability and irreversibility; third law of thermodynamics.

UNIT III PROPERTIES OF PURE SUBSTANCE 9+3

Thermodynamic properties of pure substances in solid, liquid and vapour phases; P-v-T behaviour of simple compressible substances, thermodynamic property tables and charts, psychrometric charts ideal and real gases: Vander waals equations - Reduced property - Compressibility chart - Properties of mixture of gases - Dalton's law and Gibbs - Internal energy, Enthalpy and specific heats of gas mixtures.

UNIT IV BASICS OF HEAT TRANSFER 9+3

Modes of Heat Transfer-Concept of heat resistance and electrical analogy -Conduction: One dimensional heat conduction in plane wall, composite walls and cylinder system, fins - Simple Problems - Convection - Free and forced -Flow over flat plates and tubes - Heat exchangers- Radiation -radiation laws, black, grey body radiation - radiation Shield.

UNIT V APPLICATIONS OF THERMODYNAMIC CYCLES 9+3

Internal Combustion Engines: Air-standard Otto, Diesel and dual cycles, air compressors, C.I and SI Engines - Four Stroke and two stroke Engines-Gas turbines, boilers: Fire tube boiler & Water Tube Boilers, Steam turbines; Impulse turbine and reaction turbine - Refrigeration Cycle - Vapour Compression & vapour absorption system, gas refrigeration system - Environmental friendly refrigerants -Air-Conditioning.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course the students shall be able to:

CO1. Apply first law of thermodynamics to engineering applications.
CO2. Differentiate first and second law of thermodynamics.
CO3. Examine the properties of real and ideal gas mixtures using thermodynamic charts.
CO4. Evaluate the heat transfer through conduction, convection and radiation
CO5. Analyze the thermodynamic operations on IC engine, boilers, turbine, refrigerator etc.

CO's- PO's & PSO's MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3				2					2	3	3	2
2	3	3	3				2					2	3	3	2
3	3	3	3	2			2					3	3	3	2
4	3	3	3	3			3					3	3	3	3
5	3	3	3	3			3					3	3	3	3
Avg	3	3	3	2.6			2.4					2.6	3	3	2.4

TEXT BOOKS:

1. Cengel Y.A. and Boles M.A., "Thermodynamics an Engineering Approach", 8th edition, McGraw hill, United States, 2017.
2. Nag P.K., "Engineering Thermodynamics", 6th edition, McGraw Hill, United States, 2017.
3. Holman J.P., "Heat transfer", 10th edition, McGraw Hill, United States 2017.

REFERENCES:

1. R.K.Rajput, "Engineering Thermodynamics", 3rd Edition, Laksmi Publications, New Delhi.
2. Arora C.P., "Refrigeration and Air Conditioning", 3rd Edition, Tata McGraw Hill, United States, 2017.
3. Claus Borgnakke, "Fundamentals of Engineering Thermodynamics" 8th edition, John Wiley & Sons, United States, 2013.
4. Moran M.J. and Shapiro H.N., "Fundamentals of Engineering Thermodynamics", 9th Edition, Wiley, United States, 2018.
5. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India, 2005.
6. Van Wylen and Sonntag, "Classical Thermodynamics", 4th Edition, Wiley, United States, 1994.

IE3452 APPLIED ERGONOMICS L T P C
4 0 0 4

COURSE OBJECTIVES:

- Explain the knowledge of basic human science and Engineering science.
- Teach skills associated with ergonomic measurement methods and analytical techniquesto workplace ergonomic problems.
- Plan and conduct an ergonomic analysis and ergonomic recommendations for modernwork environment problems.
- Use the occupational health and safety rules to improve the work place.
- Teach and apply ergonomic principles to design workplaces for the improvement of humanperformance.

UNIT I INTRODUCTION 12

Brief history of human factors Engineering/Ergonomics – Interdisciplinary nature- Human–machine systems -Ergonomics and its areas of application in the work system - Future directions for ergonomics- Biostatic and Biodynamic Mechanics

UNIT II WORK PLACE DESIGN 12

Problems of body size- Anthropometry measures- Work posture– Design for standing and seated workers - Design of repetitive tasks - Design of manual handling tasks- VDT work stations – Handtool design

UNIT III PHYSIOLOGICAL ASPECTS OF HUMAN AT WORK 12

Stress and fatigue -Physical work capacity - Physiological factors affecting work capacity – Fitness for work –Working hours and shift work- Quantitative work load analysis – Psychological work Demands.

UNIT IV DESIGN OF ENVIRONMENT 12

Design and Assessment in Hot, cold workplaces and the design of the physical environment– Noise and vibration- Vision –Human errors and Accidents – OSHA: Ergonomics Safety and Health Management rules – Personal Protective Equipments.

UNIT V HUMAN PERFORMANCE 12

Human Information receiving and processing – Information theory and its application – Cognitive systems - Mental Work Load -Signal detection theory -–Design of Displays and controls

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Ability to apply Knowledge of basic human science and Engineering science.
CO2: Ability to Apply skills associated with ergonomic measurement methods and analyticaltechniques to workplace ergonomic problems.
CO3: Ability to conduct an ergonomic analysis and ergonomic recommendations for modernwork environment problems.
CO4: Ability to implement the occupational health and safety rules to improve the work place.
CO5**:** Ability to apply ergonomic principles to design workplaces for the improvement of humanperformance.

TEXT BOOKS:

1. Bridger, R. S.” Introduction to Ergonomics”, 3rd ed. CRC Press, New York and London,2008
2. Martin Helander, “A guide to Ergonomics of Manufacturing”, TMH, 2006.

REFERENCES:

1. Philips, Chandler A, “Human Factors Engineering”, John Wiley and Sons, Inc. 2000
2. Sanders, M.M. & McCormick, E.J. “Human Factors in Engineering & Design “7th ed.,McGraw-Hill, NY,1993

CO’s- PO’s & PSO’s MAPPING

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1												1		
2		2	3											2	
3			3	3										1	2
4				2	3									1	
5				3											
AVg.	1	2	3	2.6	3								1	1.3	2

IE3453 ENGINEERING QUALITY CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES:

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing the special control procedures for service and process oriented industries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

UNIT I QUALITY FUNDAMENTALS 9

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality controlqualityassurance- areas of quality- quality planning- quality objectives and policies- quality costseconomicsof quality- quality loss function- quality Vs productivity- Quality Vs reliability.

UNIT II CONTROL CHARTS FOR VARIABLES 9

Process variation- preliminary decisions- control limits and their computation- construction andapplication of X bar, R and S charts- warning and modified control limits- process adjustment fortrend - Comparison of process variation with specification limits- O.C. curve for X bar chart.

UNIT III STATISTICAL PROCESS CONTROL 9

Process stability- process capability study using control charts- capability evaluation- Cp, CpkandCpm – capability analysis using histogram and normal probability plot- machine capability studygaugecapability study- setting statistical tolerances for components and assemblies- individualmeasurement charts- X-chart, moving average and moving range chart, multi-vari chart.

UNIT IV CONTROL CHARTS FOR ATTRIBUTES 9

Limitations of variable control charts- Control charts for fraction non-conforming- p and np charts, variable sample size, operating characteristic function, run length- Control chart for nonconformities(defects)- c, u, ku charts, demerits control chart- applications.

UNIT V ACCEPTANCE SAMPLING 9

Need- economics of sampling- sampling procedure- single and double sampling- O.C. Curves- Average outgoing quality- Average sample number- Average total inspection- Multiple and sequentialsampling- Standard sampling plans- Military, Dodge-Roming, IS 2500.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

CO1: Control the quality of processes using control charts for variables in manufacturing industries.

CO2: Control the occurrence of defective product and the defects in manufacturing companies.

CO3: Control the occurrence of defects in services.

CO4: Analyzing and understanding the process capability study.

CO5: Developing the acceptance sampling procedures for incoming raw material.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	1	1	1	1	1	1	2	2	1	1	2	1		2	
2	2	3	1	2	1	1	2	1	2	2	3	2	2		2
3	2	2	3	3	3	2	2	2	2	2	3	2	2		
4	2	3	3	2	2	2	2	2	1	2	2	2		1	2
5	3	2	3	3	2	2	2	2	1	2	2	2	2	1	2
AVg.	2	2.2	2	2.2	1.8	1.6	2	1.8	1.4	1.8	2.4	1.8	2	1.3	2

TEXT BOOKS:

1. Douglus C. Montgomery, "Introduction to Statistical Quality Control", Wiley-India, Seventh Edition, 2013.
2. Krishnaiah K.," Applied Statistical Quality Control and Improvement", PHI, 2014.

REFERENCES:

1. AmitavaMitra, “Fundamentals of Quality Control and Improvement”, Wiley, Fourth Edition, 2015.
2. Dale H. Besterfield, Quality Control, Pearson Education Asia, Eigth Edition, 2008.
3. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, McGraw-Hill Education, Seventh Edition, 2000.

AE3491 MECHANICS OF MACHINES L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the principles in the formation of mechanisms and their kinematics.
2. To learn the basic concepts of toothed gearing and kinematics of gear trains.
3. To study the effect of friction in different machine elements.
4. To analyze the forces and torque acting on simple mechanical systems
5. To understand the importance of balancing and vibration

UNIT I KINEMATIC ANALYSIS IN SIMPLE MECHANISMS AND CAMS 9

Mechanisms – Terminology and definitions – kinematics inversions and anlaysis of 4 bar and slide crank chain – velocity and acceleration polygons – cams – classifications – displacement diagrams - layout of plate cam profiles.

UNIT II TOOTHED GEARING AND GEAR TRAINS 9

Gear terminology – law of toothed gearing – involute gearing – Gear tooth action - Interference and undercutting – gear trains – parallel axis gear trains – epicyclic gear trains.

UNIT III FRICTION ASPECTS IN MACHINE COMPONENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt drives – Friction aspects in brakes.

UNIT IV STATIC AND DYNAMIC FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – Static equilibrium conditions – Static Force analysis in simple mechanisms – Dynamic Force Analysis in simple machine members – Inertia Forces and Inertia Torque – D’Alembert’s principle.

UNIT V BALANCING OF ROTATING MASSES AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving masses – Balancing machines – Free vibrations – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Forced vibration – harmonic Forcing – Vibration isolation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Design the linkages and the cam mechanisms for specified output motions.
CO2: Determine the gear parameters of toothed gearing and speeds of gear trains in various applications.
CO3: Evaluate the frictional torque in screw threads, clutches, brakes and belt drives.
CO4: Determine the forces on members of mechanisms during static and dynamic equilibriumconditions.
CO5: Determine the balancing masses on rotating machineries and the natural frequencies offree and forced vibratory systems

TEXT BOOK

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.

REFERENCES

1. Cleghorn. W. L., Nikolai Dechev, "Mechanisms of Machines", Oxford University Press, 2015.
2. Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt.Ltd., 2006.
3. Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 2014.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
5. Thomas Bevan, "The Theory of Machines", Pearson Education Ltd., 2010

MAPPING OF COS AND POS:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2.5	2	-	1	-	-	-	-	3	3	1	1
CO2	3	3	3	3	2	-	1	-	-	-	1	3	3	1	1
CO3	3	2.5	2.5	2.5	2	2	1	-	-	-	1	3	3	1	1
CO4	3	3	3	2.5	2	-	1	-	-	-	1	3	3	1	1
CO5	3	3	3	3	2	2	1	-	-	-	1	3	3	1	1
Avg.	3	2.7	2.9	2.7	2	0.8	1	-	-	-	0.8	3	3	1	1

GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY L T P C
2 0 0 2

UNIT I ENVIRONMENT AND BIODIVERSITY

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

IE3411 WORK SYSTEM DESIGN LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVE:

To understand the theory better and apply in practice, practical training is given in the following areas:

1. Graphic tools for method study
   a) outline process chart
   b) Flow Process Chart
   c) Two handed process Chart
2. Peg board experiment
3. Stop watch time study
4. Performance rating exercise

a. Walking rating
b. Card dealing

5. Work sampling
6. MTM practice
7. Video BasedTime Study

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students should be able

CO1: Ability to record and analyze selected tasks using different recording techniques
CO2: Ability to conduct a time study to improve the efficiency of the system.
CO3: Ability to apply MTM to improve the efficiency of the system.
CO4: Ability to conduct the work sampling study to determine the standard time
CO5: Ability to analyze the efficiency of the rating analyst in performance rating exercise

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	2	2	-	-	-	-	-	-	-	-	-			2
2	-	2	2	-	-	-	-	-	-	-	-	-		2	
3	-	2	2	-	-	-	-	-	-	-	-	-			2
4	-	2	2	-	-	-	-	-	-	-	-	-			
5	-	2	2	-	-	-	-	-	-	-	-	-		2	2
AVg.		2	2											2	2

IE3461 **OPTIMIZATION LABORATORY**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- Give adequate exposure to use different optimization software packages for solving Operations Research problems.
- Practice to solve Linear programming problems.
- Learn problem solving techniques, writing algorithms and procedures.
- Solve optimization problems using 'C' programming language.
- Practice C code for simple logic on OR problem.

LABORATORY EXPERIMENTS

Experiment 1: LP Models formulation and solving using softwares
Experiment 2: Formulation of Transportation Problem and solving using software package Experiment 3: Formulation of Assignment Problems and solving using software package
Experiment 4: Solving Maximal Flow problem
Experiment 5: Solving Minimal Spanning Tree problems
Experiment 6: Solving shortest route problems
Experiment 7: Solving Project Management problems
Experiment 8: Solving Waiting line problems
Experiment 9: Solving Queuing problems
Experiment 10: Solving Inventory problems

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Use computer tools to solve a mathematical model for practical problems.
CO2: Acquired knowledge in using Optimization Software Package.
CO3: Ability to develop C++ programming for solving optimization problem.
CO4: Able to design new simple models, like: CPM, MSPT to improve decision – makingdevelop critical thinking and objective analysis of decision problems.
CO5: Ability to use logical thinking for solving OR problem.

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1		3	3	3	1						1		3	3	
2				2	3									3	
3		3	3	3										3	2
4				3	3						2	3		3	
5	3	2											2	3	
AVg.	3	2.6	3	2.7	2.3						1.5	3	2.5	3	2