Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Third Semester (GNDEC)										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Engineering Science Courses	ESME-101	Engineering Mechanics	Theory	3	0	0	40	60	100	3
Professional Core Courses	PCME-101	Thermodynamics	Theory	3	0	0	40	60	100	3
Professional Core Courses	PCME-102	Strength of Materials	Theory	3	1	0	40	60	100	4
Professional Core Courses	PCME-103	Manufacturing Processes	Theory	3	0	0	40	60	100	3
Professional Core Courses	PCME-104	Machine Drawing and Computer Aided Design	Theory	1	0	4	40	60	100	3
Professional Core Courses	PCME-105	Engineering Materials and Metallurgy	Theory	3	0	0	40	60	100	3
Professional Core Courses	LPCME-101	Strength of MaterialsLaboratory	Practical	0	0	2	30	20	50	1
Professional Core Courses	LPCME-102	Engineering Materials and Metallurgy Laboratory	Practical	0	0	2	30	20	50	1
Professional Core Courses	LPCME-103	Manufacturing Processes Laboratory	Practical	0	0	2	30	20	50	1
Training	TR-101	Training - I*	Practical	-	-	-	60	40	100	1
Mandatory Courses		Mentoring and Professional Development#	Practical	0	0	1#	-	-	-	-
Total				**16**	**1**	**11**	**390**	**460**	**850**	**23**

Grand Total Contact Hours per week = 28

*Students will have to undergo Training-I in the college Workshops at the end of 2nd Semester for Four (04) weeks duration. Marks of internal and external evaluation of the same will be included here.

#There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Fourth Semester (GNDEC)										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Core courses	PCME-106	Theory of Machines	Theory	3	1	0	40	60	100	4
Professional Core courses	PCME-107	Applied Thermodynamics	Theory	3	1	0	40	60	100	4
Basic Science Course	BSME-101	Mathematics III	Theory	3	0	0	40	60	100	3
Professional Core courses	PCME-108	Fluid Mechanics and Machinery	Theory	3	1	0	40	60	100	4
Professional Core courses	PCME-109	Modern Manufacturing Processes	Theory	3	0	0	40	60	100	3
Professional Core courses	LPCME-104	Theory of Machines Laboratory	Practical	0	0	2	30	20	50	1
Professional Core courses	LPCME-105	Applied Thermodynamics Laboratory	Practical	0	0	2	30	20	50	1
Professional Core courses	LPCME-106	Fluid Mechanics and Machinery Laboratory	Practical	0	0	2	30	20	50	1
Professional Core courses	LPCME-107	Modern Manufacturing Processes Laboratory	Practical	0	0	2	30	20	50	1
Mandatory Courses	MPD-102	Mentoring and Professional Development*	Practical	0	0	1*	100*	0	100*	1
Total				**15**	**3**	**9**	**420**	**380**	**800**	**23**

Grand Total Contact Hours per Week = 27

*Final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

Note:

- During this semester, each student has to visit the selected local industry five times in such a way that he/she has to make at least one visit in that industry each month.
- He/ She have to maintain a record of each visit in a diary. The evaluation of these Industrial visits will be done by a committee consisting of faculty members at the end of the semester out of 20 marks.
- These marks will become part of internal marks for Training-II undergone in an Industry/ Institution of 5th semester study scheme.
- Each student has to undergo Four (04) weeks Training-II in an Industry (preferably in the same industry)/ Institution (viz. IITs/NITs/R&D Labs/ GNDEC only) at the end of 4th Semester. For writing the report the students have to follow the concerned guidelines.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Fifth Semester (GNDEC)										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Core courses	PCME-110	Finite Element Method	Theory	2	0	0	40	60	100	2
Professional Core courses	PCME-111	Design of Machine Elements	Theory	3	1	0	40	60	100	4
Professional Core courses	PCME-112	Heat Transfer	Theory	3	1	0	40	60	100	4
Humanities and Social Sciences including Management Courses	HSMME-101	Operation Research	Theory	3	0	0	40	60	100	3
Professional Core courses	PCME-113	Mechanical Measurement and Control	Theory	3	0	0	40	60	100	3
Professional Core courses	PCME-114	Industrial Automation and Robotics	Theory	3	0	0	40	60	100	3
Professional Core courses	LPCME-108	Industrial Automation and Robotics Laboratory	Practical	0	0	2	30	20	50	1
Professional Core courses	LPCME-109	Mechanical Measurement and Control Laboratory	Practical	0	0	2	30	20	50	1
Professional Core courses	LPCME-110	Heat Transfer Laboratory	Practical	0	0	2	30	20	50	1
Training	TR-102	Training –II*	Practical	-	-	-	60	40	100	1
Mandatory Courses		Mentoring and Professional Development#	Practical	0	0	1#	-	-	-	-
Total				**17**	**2**	**7**	**390**	**460**	**850**	**23**

Grand Total Contact Hours per Week = 26

There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

i. *The marks of Training-II undergone in an Industry (preferably in the same industry where industrial visits made during 4th Semester)/ Institution (viz. IITs/NITs/R&D Labs/ GNDEC only) at the end of 4th Semester will be included here.

ii. *Evaluation scheme of Training-II shall be as under:-

Internal: Out of 60 marks, 20 marks will be given on the basis of industrial visits made by the student during 4th semester. The students have to visit the selected local industry five times in the semester in such a way that in each month he/she has to make at least one visit in the same industry. He has to maintain a diary for recording the report of each visit. 40 marks shall be given on the basis of evaluation as per the rubrics.

External: External examiner should be essentially from industry and will evaluate the students on the basis of oral viva for 40 marks.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Sixth Semester (GNDEC)										
Course Category	**Course Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Core courses	PCME-115	Mechanical Vibrations	Theory	3	0	0	40	60	100	3
Professional Core courses	PCME-116	Refrigeration and Air Conditioning	Theory	3	1	0	40	60	100	4
Professional Elective courses	PEME- XXX	Elective – I (Specialization Group)	Theory	4	0	0	40	60	100	4
Professional Elective courses	PEME- XXX	Elective – II (Specialization Group)	Theory	4	0	0	40	60	100	4
Professional Core courses	LPCME-111	Mechanical Vibrations Laboratory	Practical	0	0	2	30	20	50	1
Professional Core courses	LPCME-112	Refrigeration and Air Conditioning Laboratory	Practical	0	0	2	30	20	50	1
Open Elective courses	OEZZ- XXX	Open Elective – I*	Theory	3	0	0	40	60	100	3
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-101	Minor Project **	Practical	0	0	2	60	40	100	1
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-102	Seminar	Practical	0	0	2	50	0	50	1
Mandatory Courses	MPD-103	Mentoring and Professional Development#	Practical	0	0	1#	100#	0	100	1
Mandatory Theory Courses (Non-Credit)***	MCI-10X	Open Elective	Theory	2	0	0	50	-	50	NC
Total				**19**	**1**	**9**	**470**	**380**	**850**	**23**

Grand Total Contact Hours per Week = 29

Note:-

- Each student has to undergo Four (04) weeks Training-III in an Industry/ Institution (viz. IITs/NITs/R&D Labs/ GNDEC only) at the end of 6th Semester.
- For writing the report the students have to follow the concerned guidelines.
- **The Choice for One Semester Industrial Training i.e. Choice-I (in 7th Semester) or Choice-II (in 8th Semester) or Choice-III (Degree without One Semester Industrial Training) from the students shall be taken in 6th Semester itself. This Choice-I/Choice-II of One Semester Industrial Training can be availed only once.**
- **Maximum number of students which will be allowed for One Semester Industrial Training for a particular semester shall not be more than the 50% of the student strength.**
- **If choice of One Semester Industrial Training for a particular semester by students exceeds 50%, then the guidelines issued by the Academic Section vide office order no. AS/81/study sch./82 Dated 18/01/2021 will be followed.**
- Each student has to undergo One Semester Industrial Training in an Industry (SME/LE) /Institution (IITs/NITs/R&D labs). **Student can be allowed to undergo One Semester Industrial Training abroad also provided Industry/Institution will be of equivalent nature to those mentioned here.**
- Specialization Groups of students and associated elective subjects will be finalized prior to commencement of 6th Semester.

* The open elective will be taken by a student offered by other departments, and not by his/her own department.

** The Minor Project cum Seminar will be carried out to enhance the technical report writing and presentation skills alongwith literature survey, problem formulation, assessment of viability of the project, objectives, methodology and minor theoretical / experimental analysis for the project. The Minor Project may be carried out by a group of students (2 to4). The evaluation of the Minor Project cum Seminar has to be done as per rubrics. For Writing the report students has to follow concerned guidelines.

*** Student has to pass one Mandatory Course.

There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Seventh Semester (GNDEC) – CHOICE-I										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Industry/Institution Training	TR-103	Training - III**	Practical	-	-	-	60	40	100	1
Industry/Institution Training	TR-104	Industrial Training*	Practical	-	-	30[a]	350	150	500	15
Total				**-**	**-**	**30[a]**	**410**	**190**	**600**	**16**

Note: -

- This Choice-I/ Choice-II of One Semester Industrial Training can be availed only once in 7th semester or in 8th semester respectively. The choices I/II/III from the students shall be taken in 6th semester itself.
- Maximum number of students which will be allowed for One Semester Industrial Training shall not be more than the 50% of the student strength..
- If choice of one-semester industrial training for particular semester by students exceeds 50%, then the guidelines issued by the Academic Section vide office order no. AS/81/study sch./82 Dated 18/1/2021 will be followed.
- Each student has to undergo One Semester Industrial Training in an Industry (SME/LE) /Institution (IITs/NITs/R&D labs).**Student can be allowed to undergo One Semester Industrial Training abroad also provided Industry/Institution will be of equivalent nature to those mentioned here.**

[a]Minimum

* i. During Industrial Training (TR-104) in an Industry(SME/LE) / Institution (IITs/NITs/R&D Labs), each student has to do atleast one project in concerned Industry/ Institution.

ii. Evaluation scheme of Industrial Training shall be as under:-

Internal: 350 marks shall be given on the basis of evaluation as per the rubrics.

External: External examiner from industry / Institution will evaluate the students on the basis of presentation and viva-voce for 150 marks.

** i. The marks of Training-III (TR-103) undergone at the end of 6th Semester in an Industry/ Institution (viz.IITs/NITs/R&D Labs/ GNDEC only) will be included here.

ii. Evaluation scheme of Training-III shall be as under:-

Internal: 60 marks shall be given on the basis of evaluation as per the rubrics.

External: External examiner from industry / Institution will evaluate the students on the basis of viva-voce for 40 marks.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Eight Semester (GNDEC) - CHOICE-I										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Elective courses	PEME-XXX	Elective – III (Specialization Group)	Theory	4	0	0	40	60	100	4
Professional Elective courses	PEME- XXX	Elective – IV (Specialization Group)	Theory	4	0	0	40	60	100	4
Open Elective courses	OEZZ-XXX	Open Elective – II	Theory	3	0	0	40	60	100	3
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-103	Major Project*	Practical	0	0	6	120	80	200	3
Mandatory Courses	MPD-104	Mentoring and Professional Development**	Practical	0	0	1	100**	0	100	1
Mandatory Courses (Non-credit)#	**MCME-102**	**Environmental Science**	**Theory**	**2**	**0**	**0**	**50**	**-**	**50**	**NC**
Total				**13**	**0**	**7**	**390**	**260**	**650**	**15**

Grand Total Contact Hours per Week = 20

***Students opting for Choice-I has to undergo Project –I and those who are opting for Choice-III has to undergo Project –II**. In Project – I/II the problem related with design/construction/fabrication/computer modeling/experimentation etc. based on specialization group of electives is to be carried out. The results shall be based on theoretical as well as experimental analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project. The conclusions and recommendations for future extension of the project must be covered. The evaluation of Project – I/II will be done as per the rubrics. For writing the report the students have to follow the concerned guidelines. The Project – I/II may be carried out by a group of students (2 to 4 from same specialization group). The same project problem of Project-I may be extended in the Project-II in 8th semester for Choice-III students.

** There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

NOTE: - A student can opt for CHOICE-III i.e. Degree without One Semester Industrial Training.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Seventh Semester (GNDEC) – CHOICE-II										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Elective courses	PEME- XXX	Elective – III (Specialization Group)	Theory	4	0	0	40	60	100	4
Professional Elective courses	PEME- XXX	Elective – IV (Specialization Group)	Theory	4	0	0	40	60	100	4
Open Elective courses	OEZZ- XXX	Open Elective – II	Theory	3	0	0	40	60	100	3
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-103	Major Project*	Practical	0	0	6	120	80	200	3
Training	TR-103	Training - III**	Practical	-	-	-	60	40	100	1
Mandatory Courses (Non-credit)	MCME-101	Environmental Science	Theory	2	0	0	50	-	50	NC
Mandatory Courses	MPD-104	Mentoring and Professional Development#	Practical	0	0	1#	-	-	-	-
Total				**13**	**0**	**7**	**350**	**300**	**650**	**15**

Grand Total Contact Hours per Week = 20

*In Project – I the problem related with design/construction/fabrication/computer modeling/experimentation etc. based on specialization group of electives is to be carried out. The results and analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project made with conclusions and recommendations for future extension of the project must be covered. The evaluation of Project - I will be done as per the rubrics. For writing the report the students have to follow the concerned guidelines.
The Project - I may be carried out by a group of students (2 to 4 students from same specialization group). The same project problem may be extended in the Project - II in 8th semester.

** i. The marks of Training-III in an Industry/ Institution (viz.IITs/NITs/R&D Labs/ GNDEC only) undergone at the end of 6th Semester will be included here.
ii. Each student has to do atleast one project in concerned Industry/ Institution
iii. Evaluation scheme of Training-III shall be as under:-
Internal: 60 marks shall be given on the basis of evaluation as per the rubrics.
External: External examiner from industry / Institution will evaluate the students on the basis of viva-voce for 40 marks.

NOTE: - A student can opt for CHOICE-III i.e. Degree without One Semester Industrial Training.

There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Eighth Semester (GNDEC) – CHOICE-II										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Industry/Institution Training	TR-104	Industrial Training	Practical	-	-	30[a]	350	150	500	15
Mandatory Courses	MPD-104	Mentoring and Professional Development[*]	Practical	0	0	1	100[*]	0	100	1
Total				**-**	**-**	**31[a]**	**450**	**150**	**600**	**16**

Note: -

- This Choice-I/ Choice-II of One Semester Industrial Training can be availed only once in 7th semester or in 8th semester respectively. The choices I/II/III from the students shall be taken in 6th semester itself.
- Maximum number of students which will be allowed for One Semester Industrial Training shall not be more than the 50% of the student strength.
- If choice of one-semester industrial training for particular semester by students exceeds 50%, then the guidelines issued by the Academic Section vide office order no. AS/81/study sch./82 Dated 18/1/2021 will be followed.
- Each student has to undergo One Semester Industrial Training in an Industry (SME/LE) /Institution (IITs/NITs/R&D labs).**Student can be allowed to undergo One Semester Industrial Training abroad also provided Industry/Institution will be of equivalent nature to those mentioned here.**

[a]Mimimum

[*] i. The marks of Industrial Training in an Industry/ Institution (viz.IITs/NITs/R&D Labs/ GNDEC only) undergone at the end of 6th Semester will be included here.
ii. Each student has to do atleast one project in concerned Industry/ Institution
iii. Evaluation scheme of Industrial Training shall be as under:-
Internal: 350 marks shall be given on the basis of evaluation as per the rubrics framed by department.
External: External examiner from industry / Institution will evaluate the students on the basis of viva-voce for 150 marks.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Seventh Semester (GNDEC) – CHOICE-III										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Elective courses	PEME- XXX	Elective – III (Specialization Group)	Theory	4	0	0	40	60	100	4
Professional Elective courses	PEME- XXX	Elective – IV (Specialization Group)	Theory	4	0	0	40	60	100	4
Open Elective courses	OEZZ- XXX	Open Elective – II	Theory	3	0	0	40	60	100	3
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-104	Project –I*	Practical	0	0	6	120	80	200	3
Training	TR-103	Training - III**	Practical	-	-	-	60	40	100	1
Mandatory Courses (Non-credit)	MCME-101	Environmental Science	Theory	2	0	0	50	-	50	NC
Mandatory Courses	MPD-104	Mentoring and Professional Development#	Practical	0	0	1#	-	-	-	-
Total				**13**	**0**	**7**	**350**	**300**	**650**	**15**

Grand Total Contact Hours per Week = 20

*In Project – I the problem related with design/construction/fabrication/computer modeling/experimentation etc. based on specialization group of electives is to be carried out. The results and analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project made with conclusions and recommendations for future extension of the project must be covered. The evaluation of Project - I will be done as per the rubrics. For writing the report the students have to follow the concerned guidelines.
The Project - I may be carried out by a group of students (2 to 4 students from same specialization group). The same project problem may be extended in the Project - II in 8th semester.

** i. The marks of Training-III in an Industry/ Institution (viz.IITs/NITs/R&D Labs/ GNDEC only) undergone at the end of 6th Semester will be included here.
ii. Each student has to do atleast one project in concerned Industry/ Institution
iii. Evaluation scheme of Training-III shall be as under:-
Internal: 60 marks shall be given on the basis of evaluation as per the rubrics.
External: External examiner from industry / Institution will evaluate the students on the basis of viva-voce for 40 marks.

NOTE: - A student can opt for CHOICE-III i.e. Degree without One Semester Industrial Training.

There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

Eight Semester (GNDEC) - CHOICE-III										
Category	**Code**	**Course Title**	**Subject Type (Theory / Practical)**	**Hours Per Week**			**Marks Distribution**		**Total Marks**	**Credits**
				L	**T**	**P**	**Internal**	**External**		
Professional Elective courses	PEME-XXX	Elective – V (Specialization Group)	Theory	4	0	0	40	60	100	4
Professional Elective courses	PEME- XXX	Elective – VI (Specialization Group)	Theory	4	0	0	40	60	100	4
Open Elective courses	OEZZ-XXX	Open Elective – III	Theory	3	0	0	40	60	100	3
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-105	Project –II*	Practical	0	0	6	120	80	200	3
Project Work, Seminar and Internship in Industry or Appropriate Work Place/ Academic and Research in India/Abroad	PRME-106	Futuristic Technology Project#	Practical	0	0	2	50	0	50	1
Mandatory Courses	MPD-104	Mentoring and Professional Development**	Practical	0	0	1	100**	0	100	1
Total				**11**	**0**	**9**	**390**	**260**	**650**	**16**

Grand Total Contact Hours per Week = 20

***Students opting for Choice-I has to undergo Project –I and those who are opting for Choice-III has to undergo Project –II**. In Project – I/II the problem related with design/construction/fabrication/computer modeling/experimentation etc. based on specialization group of electives is to be carried out. The results shall be based on theoretical as well as experimental analysis followed by discussion regarding suitability /non suitability of the project or any positive gain in the project. The conclusions and recommendations for future extension of the project must be covered. The evaluation of Project – I/II will be done as per the rubrics. For writing the report the students have to follow the concerned guidelines. The Project – I/II may be carried out by a group of students (2 to 4 from same specialization group). The same project problem of Project-I may be extended in the Project-II in 8th semester for Choice-III students.

#Futuristic Technology Project may be carried out by individual or group of students to demonstrate the futuristic technology to cater the needs of the society. This project may be presented and submitted in the form of virtual/Prototype/actual model etc. or poster display alongwith the report of the same in hard and soft form.

** There will be one period per week for Mentoring and Professional Development; final evaluation of this course will be done based on the combined assessment of odd and even semester of respective year of study.

[a]For Choice-I

NOTE: - A student can opt for CHOICE-III i.e. Degree without One Semester Industrial Training.

Overall Credits = 164 (Including Credits of 1st Year i.e. 41)

Overall Maximum Marks = 5800 (Including Max. Marks of 1st Year i.e. 1200)

PROFESSIONAL ELECTIVE COURSES

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

I. SPECIALIZATION GROUP

(1) THERMAL

PEME - 101	Internal Combustion Engines
PEME - 102	Cryogenic Technologies
PEME - 103	Non Conventional Energy resources
PEME - 104	Energy Conservation and Management
PEME - 105	Fluid Mechanics –II
PEME - 106	Heat Exchanger Design
PEME - 107	Solar Energy
PEME - 108	Power Plant Engineering
PEME - 109	Computational Fluid Dynamics
PEME - 110	Automobile Engineering
PEME - 111	Gas Dynamics and Jet Propulsion

(2) DESIGN

PEME - 201	Design for X
PEME - 202	Product Design and Development
PEME - 203	Machine Tool Design
PEME - 204	Tool and Cutter Design
PEME - 205	Experimental Stress Analysis
PEME - 206	Industrial Tribology
PEME - 207	Theory of Plasticity
PEME - 208	Process Planning and Cost Estimation
PEME - 209	Mechatronics
PEME - 210	Finite Element Method
PEME - 211	Modeling and Simulation
PEME - 212	Optimization Techniques
PEME - 213	Computer Aided Design
PEME - 214	Microprocessors in Automation
PEME - 215	Design of Transmission Systems

(3) MANUFACTURING

PEME - 301	Non-Traditional Machining
PEME - 302	Modern Welding and Forming Processes
PEME - 303	Computer integrated Manufacturing
PEME - 304	Computer Aided Process planning
PEME - 305	Machining Science
PEME - 306	Rapid Prototyping
PEME - 307	Characterizations of Materials
PEME - 308	Surface Science
PEME - 309	Modern Casting Processes
PEME - 310	Micromachining Technologies
PEME - 311	Manufacturing Systems
PEME - 312	Non -Destructive Testing
PEME - 313	Heat Treatment Processes

PEME - 314	Plastic Technologies
PEME - 315	Composite Materials
PEME - 316	Process Planning and Cost Estimation

II. OPEN ELECTIVE COURSES (for other branches)

OEME - 101	Industrial Safety and Environment
OEME - 102	Management Information System
OEME - 103	Entrepreneurship
OEME - 104	Operations Management
OEME - 105	Total Quality Management
OEME - 106	Industrial Engineering
OEME – 107	Non Conventional Energy Resources
PCME – 113/OEME – 108	Heat Transfer
PCME – 114/OEME – 109	Mechanical Measurement and Control
HSMME-101/OEME – 110	Operation Research
PCME-115/OEME – 111	Industrial Automation and Robotics

III. MANDATORY THEORY COURSES

MCI-102	Constitution of India
MCI-103	Organizational Behaviour

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

LIST OF DEPARTMENTAL ELECTIVE SUBJECTS

S. No.	Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
	Thermal Group		**Design Group**		**Manufacturing Group**	
Elective I (6th Semester)						
1	PEME - 110	Automobile Engineering	PEME - 202	Product Design and Development	PEME - 301	Non-Traditional Machining
2	PEME - 104	Energy Conservation and Management	PEME - 204	Tool and Cutter Design	PEME - 312	Non -Destructive Testing
Elective II (6th Semester)						
1	PEME - 103	Non-Conventional Energy resources	PEME - 209	Mechatronics	PEME - 313	Heat Treatment Processes
2	PEME - 105	Fluid Dynamics	PEME - 213	Computer Aided Design	PEME - 303	Computer integrated Manufacturing
3			PEME - 214	Microprocessors in Automation	PEME - 308	Surface Science
Elective III(7th /8th Semester)						
1	PEME - 101	Internal Combustion Engines	PEME - 215	Design of Transmission Systems	PEME - 305	Machining Science
2	PEME - 107	Solar Energy	PEME - 210	Finite Element Method	PEME - 306	Rapid Prototyping
3			PEME - 201	Design for X	PEME - 310	Micromachining Technologies
Elective IV(7th /8th Semester)						
1	PEME – 108	Power Plant Engineering	PEME - 208	Process Planning and Cost Estimation	PEME - 302	Modern Welding and Forming Processes
2	PEME - 109	Computational Fluid Dynamics	PEME - 206	Industrial Tribology	PEME - 307	Characterizations of Materials
3			PEME - 203	Machine Tool Design	PEME - 314	Plastic Technologies
Elective V(8th Semester)						
1	PEME - 111	Gas Dynamics	PEME - 211	Modeling and Simulation	PEME - 309	Modern Casting Processes
2	PEME - 106	Heat Exchanger Design	PEME - 212	Optimization Techniques	PEME - 315	Composite Materials
Elective VI(8th Semester)						
1	PEME - 102	Cryogenic Technologies	PEME – 205	Experimental Stress Analysis	PEME - 304	Computer Aided Process planning
2			PEME - 207	Theory of Plasticity	PEME - 311	Manufacturing Systems

Study Scheme
B. Tech. (Mechanical Engineering)
2018 Admission Batch Onwards

OPEN ELECTIVE COURSES (for other branches)

S.No.	Semester	Subject	Subject Name	Subject Code
1	6th	Open Elective-I	Total Quality Management	OEME-105
2	6th	Open Elective-I	Industrial Engineering	OEME-106
3	6th	Open Elective-I	Entrepreneurship	OEME-103
4	7th/8th	Open Elective-II	Industrial safety and Environment	OEME-101
5	7th/8th	Open Elective-II	Mechanical Measurement and control	PCME-114/OEME-109
6	7th/8th	Open Elective-II	Industrial Automation and Robotics	PCME-115/OEME-111
7	8th	Open Elective-III	Management Information System	OEME-102
8	8th	Open Elective-III	Operations Management	OEME-104
9	8th	Open Elective-III	Non-Conventional Energy Resources	OEME-107

Subject Code: ESME-101 **Subject Name: Engineering Mechanics**

Programme: B.Tech.(ME**)**	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 70%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the meaning of Engineering Mechanics.
2	Solve the problem related to the behaviour of a rigid body due to an external load.
3	Solve, analyze and design moment of area of plane figures.
4	Analyze the mass moment of solid objects.
5	Apply the Work-Energy Equation and Impulse-Momentum equation.
6	Analysis and Solve friction related problems.

Detailed Contents:

Part-A

1. **Basics and Statics of particles:**Introduction: Units and Dimensions ; Laws of Mechanics : Lami's theorem, Parallelogram and triangular; Law of forces:Vectorial representation of forces , Vector operations of forces: additions, subtraction, dot product, cross product ; Coplanar Forces : rectangular components ; Equilibrium of a particle, Forces in space , Equilibrium of a particle in space , Equivalent systems of forces , Principle of transmissibility. **07 Hrs**

2. **Equilibrium of Rigid Bodies:** Types of supports; Free body diagram; Action and reaction forces; stable equilibrium ; Moments and Couples : Moment of a force about a point and about an axis,Vectorial representation of moments and couples , Scalar components of a moment; Varignon's theorem: Single equivalent force, Equilibrium of Rigid bodies in two dimensions ,Equilibrium of Rigid bodies in three dimensions. **07 Hrs**

3. **Properties of Surfaces and Solids:** Centroids and centre of mass; Centroids of lines and areas: Rectangular, circular, triangular areas by integration, T section, I section, Angle section, Hollow section by using standard formula ; Theorems of Pappus: Area moments of inertia of plane areas: Rectangular, circular, triangular areas by integration, T section, I section, Angle section, Hollow section by using standard formula ; Parallel axis theorem and perpendicular axis theorem : Principal moments of inertia of plane areas, Principal axes of inertia, Mass moment of inertia ;mass moment of inertia for prismatic, cylindrical and spherical solids from first principle; Relation to area moments of inertia. **07 Hrs**

Part-B

4. **Friction:** Friction force: Laws of sliding friction, equilibrium analysis of simple systems with sliding friction, wedge friction;Rolling resistance. **04 Hrs**
5. **Dynamics of Particles:** Displacements, Velocity and acceleration, their relationship, Relative motion, Curvilinear motion; Newton's laws of motion ; Work Energy Equation; Impulse and Momentum; Impact of elastic bodies. **07 Hrs**
6. **Dynamics of Rigid Bodiesand its application:** Translation and Rotation of Rigid Bodies, Velocity and acceleration, General Plane motion of simple rigid bodies such as a cylinder, disc/wheel, and sphere. **04 Hrs**

Text Books

1. Russell C. Hibbeler,*"Engineering Mechanics: Statics & Dynamics"*, Pearson Publishers 14th Edition, 2016.
2. R.K. Banal, *"Engineering Mechanics"*, Luxmi publishers" 8th Edition, 2016.
3. Irving H. Shames, *"Engineering Mechanics"*, Prentice Hall, 4th Edition, 2006
4. R. C. Hibler and Ashok Gupta,*"Engineering Mechanics (Statics, Dynamics)"*, Pearson Education,11th Edition,2010
5. F. P. Beer and E. R. Johnston, *"Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics"*, Tata McGraw Hill Publishing, 9th Edition, 2011

Reference Books

1. K.L Kumar, *"Engineering Mechanics"*, Tata McGraw-Hill Publishing Company,3rdEdition2008.
2. S Rajasekaran and G.Sankarasubramanian, *"Engineering Mechanics Statics and Dynamics"*, Vikas Publishing House Pvt. Ltd., 3rd Edition,2005.
3. E. Nelson, Charles Best, William Mclean, Merle Potter, *"Schaum's Outline of Engineering Mechanics: Statics",* McGraw-Hill Education; 6thEdition, 2010. (E-Book Available)
4. E. Nelson, Charles Best, William Mclean, Merle Potter,*"Schaum's Outline of Engineering Mechanics Dynamics"*, McGraw-Hill Education,2010. (E-Book Available)
5. Robert W. MesslerJr.,*"Reverse Engineering: Mechanisms, Structures, Systems &Materials"*,McGraw-Hill Education, 1stEdition, 2013). (E-Book Available)

Subject Code: PCME-101 **Subject Name: Thermodynamics**

Programme: B.Tech.(ME**)**	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 70%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand and use basic concepts and First Law of Thermodynamics for engineering applications.
2	Apply the Second law of Thermodynamics and related properties for the feasibility of engineering systems and solve engineering problems.
3	Recognize the nature of substance from the understanding of its properties and use related Tables and Charts.
4	Evaluate and analyze the performance of Air Standard and Vapor power cycles.
5	Apply combustion equations to analyze the products of combustion and combustion phenomenon.
6	Select IC Engine for a particular application.

Detailed Contents:

PART-A

1. **Basic concepts and First law of Thermodynamics:**Brief concept of continuum, Thermodynamic System, Boundary and Surroundings, Control(fixed) mass and Control Volume concept, Thermodynamic State, Thermodynamic Property, Condition for any quantity to be a property, Thermodynamic equilibrium, Thermodynamic path, Thermodynamic process, Concept of reversible process, Quasi-static process, Irreversible process, Cyclic process, Thermodynamic Cycle, Energy and its forms; Physical insight to internal energy, Energy transfer across system boundary i.e. transient energies, Heat and work transfer- their comparison and sign conventions, Displacement work and other modes of work, Zeroth law of Thermodynamics, First law of Thermodynamics and its applications to closed and open system, Steady and unsteady flow processes. **06 Hrs**

2. **Second law of Thermodynamics:**Limitations of first law of Thermodynamics, Heat reservoir, source and sink, Heat engine, Refrigerator, Heat pump, Kelvin-Plank and ClausiusStatements of second law and their corollaries, Carnot and reversed Carnot cycle, Concept of entropy, T-S diagram, Principle of increase in entropy, Applications of second law, High grade and low grade energy, Available and non-available energy, Enthalpy and entropy as a function of independent variables, Third law of Thermodynamics.
08 Hrs

3. **Properties of pure substances and Gas Mixtures:**Formation of steam and its Thermodynamic properties, p-V, T-S and an h-s diagram for a pure substance, Use of the steam table and Mollier chart, Determination of dryness fraction, Equation of State of a Gas, Ideal Gas, Internal energy, Enthalpy and Entropy of Gas Mixtures. **06Hrs**

PART-B

4. **Thermodynamic cycles:**Air standard cycle: Otto cycle, Diesel cycle, Dual cycle and Brayton cycle; Vapor power Cycles: Steam power cycles, Rankine Cycles, Comparison of Rankine and Carnot Cycles, Reheat Cycle, Regenerative Cycles, Reheat – Regenerative Cycle, Binary Vapor Cycles, Thermodynamics of combined cycles. **08Hrs**
5. **Combustion of fuel: T**ypes of fuels, Combustion of fuel, Combustion equations, Minimum air requirements and air-fuel ratio, Wet and dry analysis of products of combustion, Conversion of volumetric analysis into gravimetric analysis and vice-versa, Enthalpy of formation, Enthalpy of reaction, Adiabatic flame temperature. **08 Hrs**

6. **Introduction to IC Engines: I**ntroduction to heat engines; Merits of I.C. Engines and their important applications, Classification and constructional features of I.C. Engines; Working of two stroke and four stroke Petrol and Diesel engines and their comparison. **04 Hrs**

Text Books:

1. P.K. Nag, *"Engineering Thermodynamics"*, McGraw Hill Education (India), Chennai, 6th Edition 2017.
2. V. Ganeshan, *" Thermal Engineering"*,McGrawHill Education (India), Chennai
3. Y.A. Cengel, M.A.Boles, *"Thermodynamics – An Engineering Approach"*, McGraw HillEducation,8thEdition 2017.
4. R. E. Sonntag, C. Borgnakke, &G. J. V. Wylen, *"Fundamentals of Thermodynamics"*, Wiley, 7thEdition 2009.
5. M. J. Moran, H. N. Shapiro, D. D. Boettner&M. Bailey, *"Fundamentals of Engineering Thermodynamics"*, John Wiley & Sons, 7thEdition, 2010.

Reference Books:

1. J. B. Jones, &R. E. Dugan, *"Engineering Thermodynamics"*, Prentice Hall, 1st Edition 1995.
2. D.B. Spalding, E.H. Cole, *"Engineering Thermodynamics"*, Edward Arnold, London,1982.
3. V.G. Erokhim, M.G. Makhan, *"Fundamentals of Thermodynamics and Heat Engines"*, Mir Publishers, Moscow, 1986.
4. I. Shvets, V. Tolubinsky, *"Heat Engineering"*, MedTech Science and Technology Series, 2ndEdition 1975.

Topics for Self Learning (TSL)
1. Concept of Irreversibility
2. Types of steam generators
3. Gibbs Function of a mixture
4. Maxwell's Equations
5. Combustion phenomenon in IC Engines (Knocking and detonation)

Subject Code: PCME-102 **Subject Name: Strength of Materials**

Programme: B.Tech. (ME)	**L:** 3 **T:** 1 **P:** 0
Semester: 4	**Teaching Hours:** 39
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 70%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Formulate mechanics problems using calculus and differential equations.
2	Solve, analyze and design beams under bending stresses.
3	Understand the design considerations of structures subjected to different/wide range of loading conditions including thermal loads.
4	Relate the design problems with practical applications.
5	Solve problem involving simple and combined modes, including torsion.
6	Evaluate slope and deflection in different type of beams under different loading conditions.

Detailed Contents:

Part-A

1. **Simple Stresses and Strains:** Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self-weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Thermal stresses and strains: Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. **07 Hrs**
2. **Principal Stresses and Strains**: Two-dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle for stresses and strains, principal stresses related to principal strains. Strain energy: Introduction to strain energy, strain energy in simple tension and compression. Stresses develop due to a different type of loads. Strain energy in pure shearing, torsion, and due to bending; Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of the equation for these theories and their application to problems related to two-dimensional stress systems. **07 Hrs**
3. **Bending Moment (B.M) and Shear Force (S.F) Diagrams:** Shear force and Bending Moment definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum bending moment, Shear force and Point of contra flexure under the

following type of loads: a) Concentrated loads b) Uniformity distributed loads over the whole span or part of span c) Combination of concentrated and uniformly distributed load d) Uniformly varying loads e) Application of moments. **07Hrs**

Part-B

4. **Bending Stresses in Beams:** Bending theory; assumptions, derivation of bending equation and its application to beams of rectangular, circular and channel, I and T- sections. Combined, direct and bending stresses in afore-mentioned sections, composite / flitched beams **04 Hrs**
5. **Torsion:** Derivation of torsion equation, its assumptions and application on the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts, principal stresses and maximum shear stresses under combined loading of bending and torsion. **04 Hrs**
6. **Deflection in beams:** Relationship between moment, slope and deflection, Double integration method, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following: a. Cantilevers b. simply supported beams with or without overhang under concentrated loads, uniformly distributed loads or combination of concentrated & uniformly distributed loads. **07Hrs**
7. **Thin cylinders and spheres:** Calculation of Hoop stress, longitudinal stress in a cylinder, the efficiency of joints, changes in dimensions due to internal pressure. Principal stresses in a spherical shell, change in diameter and internal volume. **02Hrs**

Text Books

1. S.S. Rattan, *"Strength of Materials",* Tata McGraw Hill, 11th Edition, 2014 (E-Book).
2. R.S. Lehri, *"Strength of Materials"*, Katson, 11th Edition, 2012.
3. Egor P. Popov, *"Engineering Mechanics of Solids"*, Prentice Hall of India,2nd Edition,2001.
4. R. Subramanian, *"Strength of Materials"*, Oxford University Press, 3rd Edition, 2007.
5. Timoshenko, *"Mechanics of Materials"*, CBS Publication, 2nd Edition, 2006.

Reference Books

1. Kirpal Singh, *"Mechanics of Materials"*, Standard Publishers, 7th Edition, 2013.
2. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, *"Mechanics of Materials"*, Tata Mc-GrawHill Publishing Co. Ltd., 2005.
3. Sadhu Singh, *"Strength of Materials"*, Khanna Publication, 11th Edition, 1978.
4. Russell C. Hibbeler, *"Mechanics of Materials",*Pearson Publications, 10th Edition, 2016.

Subject Code: PCME-103 **Subject Name: Manufacturing Processes**

Programme: B.Tech.(ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: Manufacturing Practices

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Use the Knowledge of Fundamental principles of Castings, Welding, forming and cutting processes for their practical applications.
2	Identify and suggest equipment, tools and accessories required for performing the various manufacturing processes.
3	Know about cutting tools and their materials and related concepts like tool life, wear, and coolants/lubricants.
4	Identify various machine tools and knowledge of different parameters of the processes for analyzing their effect.
5	Suggest a suitable process for manufacturing of component.
6	Understand the latest technologies in Manufacturing Processes.

Detailed Contents:

Part-A

1. **Introduction:** Classification of manufacturing processes; Selection criteria for manufacturing processes; General trends in manufacturing. **02Hrs**
2. **Casting Processes:** Introduction to metal casting; Patterns: types, materials and allowances; Moulding materials: moulding sand compositions and properties, sand testing, types of moulds, moulding machines. Cores: function, types, core making process, core-prints, chaplets. Gating system design, Riser design. Melting furnaces, and Metallurgical considerations in casting, Solidification of metals and alloys, Directional solidification, Segregation, Nucleation and Grain growth. **10Hrs**
3. **Welding Processes:** Introduction and classification of welding processes;Principle , Equipment and constructional details for Gas welding, Electric Arc welding, relative merits of AC & DC arc welding; Electrodes: types, selection, electrode coating ingredients and their function; Thermal effects on weldment: heat affected zone, grain size and its control; Resistance welding: principle and their types. TIG and MIG welding processes: principle, equipment and constructional details. **10Hrs**

Part - B

4. **Metal Forming:** Introduction and classification; Rolling process: introduction, classification, rolling mills, products of rolling, rolling defects and remedies; Forging: open and closed die

forging, forging operations, forging defects, their causes and remedies; Extrusion: classification, equipment, defects and remedies; Drawing: drawing of rods, wires and tubes, drawing defects and remedies;Introduction to sheet metal forming operations. **06Hrs**

5. **Metal Cutting:** Introduction to machining processes; Cutting tool geometry, Cutting tool materials: high carbon steels, alloy carbon steels, high-speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN; Mechanics of chip formation process, concept of shear angle and cutting forces in metal cutting; Merchant theory, tool wear, tool life, machinability; **05Hrs**
6. **Machine Tools**:Classification, description and operations of Lathe machine,Shaping and planingmachine, Milling machine, Boring machine; Broaching machine. **05Hrs**

Text Books

1. P. N. Rao, *"Manufacturing Technology, Foundry, Forming & Welding",* Tata McGraw Hill, 4th Edition, 2017
2. P. N. Rao, *"Manufacturing Technology, Metal Cutting and Machine Tools",* Tata McGraw Hill, 4th Edition, 2017
3. B. L. Juneja and G. S. Sekhon, *"Fundamentals of Metal Cutting & Machine Tools",* New Age International (P) Ltd, 2nd Edition, 2017.
4. P. C. Sharma, *"A Text Book of Production Technology",* S. Chand & Company Ltd., 8th Edition, 2014.
5. H. S. Shan, "*Manufacturing Processes*", Cambridge University Press, 2nd Edition, 2018.

Reference Books:

1. SeropeKalpakjian and Steven R. Schmid, *"Manufacturing Engineering and Technology",* Pearson Publishers, 4th Edition, 2002.
2. J.A. Schey, "*Introduction to Manufacturing Processes*" ,McGraw Hill Co., 3rd Edition 2000.
3. G. Boothroyd and W.A. Knight, "*Fundamentals of Machining and Machine Tools*", 2nd Edition, Marcel Dekker, Inc., 1989.
4. Uday S. Dixit, *"Metal Forming: Technology and Process Modeling"*, McGraw-Hill Professional, 2013. (E-book available)
5. HwaiyuGeng, *"Manufacturing Engineering Handbook,"* McGraw-Hill Professional2nd*Edition.*(E-book available)
6. Jonathan Beddoes, M. J.Bibby, *"Principles of Metal Manufacturing Processes"*, Butterworth Heinemann Elsevier Publications.(E-book available)

Subject Code: PCME-104 Subject Name: Machine Drawing and Computer Aided Design

Programme: B.Tech.(ME)	**L:** 1 **T:** 0 **P:**4
Semester: 4	**Teaching Hours:** 60
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 90%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: Engineering Drawing and Graphics.
Additional Material Allowed in ESE: [Scientific Calculator]
On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	To acquire the knowledge of CAD software and its features.
2	To inculcate an understanding of the detail/assembly drawings using orthographic projections and sectional views.
3	To familiarize the students with Indian Standards on drawing practices.
4	To impart knowledge of thread forms, fasteners, keys, joints and couplings.
5	To make the students interpret drawings of machine components so as to prepare assembly drawings either manually and using CAD packages.
6	To acquire the knowledge of limits fits and tolerance pertaining to machine drawings.

Detailed Contents:

Part–A (Theory)

Traditional Machine Drawing (TMD) and Computer Aided Design (CAD)

1. **Introduction:**Requirements of machine drawing;Review of Sectioning and conventional representation, Dimensioning, Machining Symbols, introduction and Familiarization of Code SP 46:2003. **01Hrs**
2. **Fasteners:** Various types of screw threads, nuts and bolts, screwed fasteners, welding joints, riveted joints, knuckle joint, couplings, keys and cotter. **02Hrs**
3. **Assembly in First Angle Projection of Various Mechanical Components**:Plummer Block, Foot Step Bearing, Steam Stop Valve, spring-loaded Safety Valve, Blow-off Cock, Tail Stock, Screw Jack,Expansion Joint. **03Hrs**
4. **Introduction to CAD:** Introduction to CAD and its role in Product design and development cycle; CAD system; advanced input and output devices; Functions of a graphics package; Digital Printing, Rapid Prototyping, Application areas of CAD. **01Hrs**
5. **Fits and Tolerance:** Theconcept of limits, fits & tolerances and their representation; types of fits: running , sliding , location, assembly, transition and interference ;ISO system of tolerance , tolerance zones, and grades; tolerance types : dimensional and geometric ; Gauging

Part – B (Practice) TMD and CAD

Use of Traditional Machine Drawing (TMD)

1. Types of sectioning, limits, fits & tolerances; machining and weldingsymbols. **02 Hrs**
2. Sketches of various fasteners (screw threads, nuts and bolts, screwed fasteners, riveted joints, keys and cotter) **04Hrs**
3. Freehand sketches **06Hrs**

   a) Couplings: Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, universal coupling, cone friction clutch, single plate friction clutch.

   b) **Pulleys:** fast and loose pulleys, stepped pulleys.

   c) Knuckle and cotter joints, keys; Spigot and socket joint, Union joint.
4. **Assembly in First Angle Projection of Various Mechanical Components:** Plummer Block, Foot Step Bearing, Steam Stop Valve, spring-loaded Safety Valve, Blow-off Cock, Tail Stock, Screw Jack. **18 Hrs**

Use of 3D CAD software

5. Practice of 2D drawing using sketcher. **03 Hrs**
6. 3D modelling using 3D features. **06 Hrs**
7. Drafting and assembling of (any one from Plummer Block, bench vice, Screw Jack,Steam Stop Valve, knuckle joint etc.) with proper mating conditions and interference checking using 3D software. **08 Hrs**
8. Surface modelling (Computer mouse; Plastic bottles). **05 Hrs**

Text Books:

1. Ajeet Singh, *"Machine Drawing (including Auto CAD)"*, McGraw Hill, 2nd edition, 2012
2. N.D. Bhatt, *"Machine Drawing"*, Charotar publications,50th Edition, 2014
3. P.S. Gill, *"Machine Drawing"*, S K Kataria and Sons, 18th edition, 2017 Reprint
4. MikellP.Groover, Emory W. Zimmer's, *"CAD/CAM: Computer-Aided Design and Manufacturing"*, PHI, 2nd Edition, 1984.
5. D. D.Bedworth, M. R Henderson & P.M. Wolfe, *"Computer Integrated Design and Manufacturing"*, McGraw Hill,2nd Edition, 1991.
6. Z.Ibraham, *"CAD/CAM - Theory and Practice"*, McGraw Hill, 2nd Edition, 2009.

Reference Books:

1. Gene R. Cogorno,*"Geometric Dimensioning and Tolerancing for Mechanical Design"*, McGraw-Hill Professional, 2nd Edition,2011. (E-Book Available)
2. Paul Drake, Jr., *"Dimensioning and TolerancingHandbook"*, McGraw-Hill Professional, 1st Edition, 1999.(E-Book Available)
3. Joseph E. Shigley,*"Standard Handbook of Machine Design"*, McGraw-Hill Professional,3rdEdition2004.(E-Book Available)

Subject Code: PCME 105 **Subject Name: Engineering Materials and Metallurgy**

Programme: B.Tech.(ME**)**	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 38
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NIL

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Ability to differentiate ferrous and non-ferrous metals.
2	Explain the significance of the metallurgical characteristics of engineering materials (both ferrous and non-ferrous).
3	Explain the theories of diffusion, plastic deformation and re-crystallization.
4	Analyze various heat treatment processes and their applications for ferrous materials.
5	Explain the role of Fe-C and TTT diagram for controlling the desired structure and properties of the materials.
6	Suggest the methods to determine the harden-ability of materials.

Detailed Contents:

Part-A

1. **Ferrous and Non Ferrous Metals:** Introduction, classification and composition of alloy steels, effect of alloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel. Non-Ferrous Metals & Alloys: Aluminum, Magnesium and Copper alloys: Composition, Properties and Applications. **08 Hrs**
2. **Crystallography:**Atomic bonding in solids, crystal systems, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; coordination number,APF,c/a ratio of HCP.Crystallographic notation of atomic planes;; imperfection in solids; point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and non-steady-state diffusion, factors affecting diffusion. Theories of plastic deformation; slip and twinning, recovery, re-crystallization. **08 Hrs**

Part-B

3. **Heat Treatment:** Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburizing, nitriding and cyaniding. Harden-ability: determination of harden-ability. Jominy end-quench test.Defects due to heat treatment and their remedies. **10 Hrs.**

4. **Phase Transformation:** General principles of phase transformation in alloys, Types of equilibrium diagrams: Two metals completely soluble in the liquid state and completely soluble in the solid state, Eutectic (Two metals completely soluble in the liquid state but completely insoluble in the solid state & Two metals completely soluble in the liquid state but partly soluble in the solid state), Peritectic, Eutectoid and Peritectoid system. Polymorphism and allotropy; allotropy of iron. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications. **12 Hrs**

Text Books

1. Sidney H Avner, *"Introduction to Physical Metallurgy"*, Tata McGraw-Hill. 2nd Edition, 2017
2. O.P. Khanna, *"A Text book of Materials Science & Metallurgy"*, DhanpatRai& Sons. Re-print 1984
3. U. C. Jindal, *"Material Science and Metallurgy"*, Pearson. Re-print 2011(E book)
4. Parashivamurthy K.I, *" Material science and metallurgy"*, Pearson Re-print 2012(E book)
5. Lakhtin,Yu.M,*"Engineering physical metallurgy and Heat treatment"*, Mir Publishers. Re-print 1986

Reference Books

1. V. Raghavan, *"Physical Metallurgy: Principles and Practice"*, PHI Learning. 3rdEdition 2015
2. B. Zakharov, *"Heat Treatment of Metal"*, University Press.1984
3. George S. Brady, *"Materials Handbook: An Encyclopedia for Managers, Technical Professionals, Purchasing and Production Managers, Technicians, and Supervisors"*, McGraw-Hill Publication, 15thEdition, 2002.
4. Smallman, R.E. Ngan, A.H.W.,*"Modern Physical metallurgy"*Butterworth-Heinemann,8th Edition 2013.

Subject Code: LPCME-101 **Subject Name: Strength of Materials Laboratory**

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 3	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):**2hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Conduct mechanical testing (Tensile, compression, Impact, bending, torsion of various materials).
2	Compare mechanical properties of various materials.
3	Analyse buckling load of long columns.
4	Understand load –deflection relation of helical spring.
5	Conduct fatigue testing of the materials.
6	Conduct hardness test on various materials.

Sr.No.	Name of Practical
1.	To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2.	To perform compression test and impact tests on the given specimen
3.	To perform hardness test. (Aluminium, Mild steel and Hardened steel)
4.	To perform torsion test and to determine various mechanical properties of the given material
5.	To perform bending test on beam and to determine the Young's modulus and modulus of rupture
6.	To determine buckling load of long columns with different end conditions.
7.	To draw load/ defection curve for helical spring
8.	To perform Fatigue test on circular test piece.

R**eference Material**

Manuals available in Lab.

Subject Code: LPCME-102 Subject Name: Engineering Materials and Metallurgy Laboratory

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:**2
Semester: 3	**Teaching Hours:** 20
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 1 hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Knowledge of Engineering Metallurgy and Heat treatment.

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Identify various Crystal structures of different samples.
2	Compare various micro structures from standard specimens and compare with standard specimen.
3	Create/Prepare specimens of mild steel for study of microstructure.
4	Perform various Heat Treatment Processes practically on Specimens.
5	Determine the effect of various Quenching media on properties of steel.
6	Use different methods to determine Hardenability of steel specimens.

Special Instruction related to resources requirement: Instruments should be used under guidance of Lab Technician or Teacher.

Sr.No.	Name of Practical
1.	Preparation of models/Charts related to Atomic /Crystal Structures of Metals.
2.	To prepare specimen involving cutting, mounting, polishing and etching of Mild Steel and to study microstructure of prepared specimen.
3.	To study the microstructure of following materials from standard specimens. 1) Hypo eutectoid and hyper eutectoid steel. 2)White and Grey Cast Iron 3) Non Ferrous Metals: Brass, Copper 4) Heat Treated Specimens: Annealed, Normalized,Hardened
4.	To conduct Normalizing on Steel specimen and to study the effect of Normalizing on Hardness and Microstructure
5.	To conduct Hardening of Steel specimen and to study the effect of Hardening on Hardness and Microstructure.
6.	To determine the effect of different quenching media (Water, Oil, Brine solution) on Hardness of Steel Specimen.
7.	To determine Hardenability of steel by Jominy End Quench test.

Reference Material

Manuals available in Lab.

Subject Code: LPCME-103 Subject Name: Manufacturing Processes Laboratory

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:**2
Semester: 3	**Teaching Hours:** 20
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 1 hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Manufacturing Practices

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Conduct various tests on molding sand
2	Determine major characteristics of molding sand.
3	Use the equipments like TIG MIG, welding and study the effect of various process parameters on weld quality.
4	Learn about grinding practice of single and multipoint cutting tools for efficient use of grinding equipment.
5	Use conventional cutting machine tools like milling for given jobs /work pieces.
6	Determine cutting forces with the use of tool dynamometer.

Special Instruction related to resources requirement: Instruments should be used under guidance of Lab Technician or Teacher.

Sr.No.	Name of Practical
1.	To determine grain fineness number, clay content and moisture content of a given sample of moulding sand.
2.	To Prepare a specimen of moulding sand on a standard Rammer and to carry out following tests: a) Tensile, compressive and transverse strength b)Mould Hardness c) Shatter index d)Permeability
3.	To study the effect of process parameters of MIG Welding (Voltage, wire feed, gas flow) on welding of Mild steel sheet.
4.	To study the effect of process parameters of TIG welding (Pulse, Gas flow, current) on welding of Stainless steel and Mild steel sheets.
5.	To grind single point and multipoint cutting tools and to prepare introductory report on cutting inserts.
6.	To determine cutting forces with dynamometer for turning operation.
7.	To prepare a job of spur gears by the use of milling machines.

R**eference Material**

Manuals available in Lab.

Subject Code: PCME-106 **Subject Name: Theory of Machines**

Programme: B.Tech.(ME**)**	**L:** 3 **T:** 1 **P:** 0
Semester: 4	**Teaching Hours:** 40
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 70%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understanding the basic concept of kinematics and kinetics of machine elements.
2	Evaluate forces and couples applied to the machine elements.
3	Understand the function and application of gears and Evaluate the velocity ratio and torque in different gear trains.
4	Creating and designing of different types of cams.
5	Applying the concept of Static and dynamic balancing of rotating and reciprocating masses.
6	Understand the function of belt drives, brakes and clutches.

Detailed Contents:

Part-A

1. **Basic Concept of machines**: Degree of Freedom, Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain.Grashoff's criterion, Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms (including Corliolis Components). **05Hrs**
2. **Force analysis**: Introduction, Concept of force and couple, free body diagram, condition of equilibrium, Static equilibrium of mechanisms, methods of static force analysis of simple mechanisms. **05Hrs**
3. **Gears and Gear Trains**: Toothed gears and their applications, types of toothed gears and its terminology. Conditions for correct gearing, forms of teeth, length of Path of contact, length of arc of contact, contact ratio, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth required on pinion and wheel for helical, spiral, bevel, worm gears and involute rack. Center distance for spiral gears and efficiency of spiral gears. Gear Trains: Types of gear trains such as simple, compound and epicyclic**.** **09Hrs**

Part-B

4. **Friction Devices:** Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Belt and Rope Drives : Flat and V-belts, Rope , Idle Pulley, Intermediate or Counter Shaft Pulley, Velocity Ratio, Crowning of Pulley, Loose and fast

pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip. **06Hrs**

5. **Cams**: Types of cams and follower, definitions of terms connected with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion).Analysis of follower motion for circular, convex and tangent cam profiles . **06 Hrs**
6. **Balancing**: Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses, partial balancing of locomotives, swaying couple, variation of tractive effort and hammer blow condition of balance in multi cylinder in line and V-engines, concept of direct and reverse crank, balancing of machines, rotors and reversible rotors, two plane balancing of rotor **08Hrs**

Text Books

1. S.S.Rattan, *"Theory of Machines"*, McGraw Hill Publications, 4th Edition, 2014.
2. Sadhu Singh, *"Theory of Machines"*, Pearson Education, 2nd Edition, 2009.
3. Thomas Bevan, *"Theory of Machines"*, CBS Publishers & Distributors, 3rd Edition 2005.
4. Robert L. Norton, *"Kinematics and Dynamics of Machinery"*, Tata McGraw-Hill, 1stEdition 2009.
5. Ghosh A. and Mallick A.K., *"Theory of Mechanisms and Machines"*, Affiliated EastWest Pvt. Ltd, New Delhi, 3rd Edition 1988.

Reference Books

1. Joesph E. Shigley, *"Theory of Machines"*, Tata McGraw Hill Publications, 2nd Edition, 2011
2. V.P. Singh, *"Theory of Machines"*, DhanpatRai and Sons Publications, 2ndEdition,2004.
3. W.LCleghorn. ,*"Mechanisms of Machines"*, Oxford University Press, CDR Edition, 2005.

Topics for Self Learning (TSL)
1. Inertia forces and couples in machine parts. 2. Different types of brakes such as ABS and EBD and their applications. 3. Applications of Compound epicyclic gear trains. 4. Function of Governors and Flywheels.

Subject Code: PCME-107 **Subject Name: Applied Thermodynamics**

Programme: B.Tech.(ME**)**	**L:** 3 **T:** 1 **P:** 0
Semester: 4	**Teaching Hours:** 39
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 50%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand various types of steam turbines and analyze various performance parameters.
2	Estimate the amount of cooling water required in a specific type of condenser.
3	Understand working principles and performance parameters of reciprocating and rotary compressors.
4	Understand working principles and performance parameters of Centrifugal and axial flow compressors.
5	Conduct thermal analysis of various types of gas turbines and their performance investigation.
6	Understand various types of jet propulsion systems and common propellants.

Detailed Contents:

PART-A

1. **Steam Turbines:** Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overall efficiency, Reheat factor, Bleeding, Velocity diagram of simple and compound multistage impulse and reaction turbines and related calculations, work done, efficiencies of reaction, Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines, Comparison with steam engine. **04Hrs**
2. **Steam Condensers:**Function of steam condensers, Elements of condensing unit, Types of condensers, Dalton's law of partial pressures applied to the condenser problems, Condenser and vacuum efficiencies, Cooling water calculations, Effect of air leakage, Method to check and prevent air infiltration, Description of air pump and calculation of its capacity, cooling towers: function, types and their operation. **04Hrs**
3. **Reciprocating and rotary compressors:** Introduction, Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places Single stage single acting reciprocating compressor (with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytrophic, mechanical efficiency, Clearance Volumetric efficiency, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage compressors: purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; isothermal, overall thermal, isentropic, polytropic and mechanical

efficiencies Comparison of rotary positive displacement compressors with reciprocating compressors, like Roots blower, Lysholm compressor and Vane type Blower. **07 Hrs**

Part-B

4. **Centrifugal & Axial Flow Compressors:** Complete thermodynamic analysis of centrifugal compressor stage; Polytrophic, isentropic and isothermal efficiencies, Pre-guide vanes and pre-whirl; Slip factor, Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of slip factor, Surging and choking in compressors, Different components of axial flow compressor and their arrangement; Discussion on flow passages and simple theory of aero-foil blading; Angle of attack; coefficients of lift and drag; Turbine versus compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work done on the compressor and power calculations, Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors. **08 Hrs**
5. **Gas Turbines**:Classification and comparison of the Open and Closed cycles; Classification on the basis of combustion (at constant volume or constant pressure); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and re-heating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle, Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials. Gas turbine fuels. **08 Hrs**
6. **Jet Propulsion:**Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like (i) Athodyd (ramjet and pulsejet), (ii) Turbojet engine, and (iii) Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal (internal) efficiencies; Overall thermal efficiency; Specific fuel consumption; Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors (e.g. solid propellant and liquid propellant systems); Various common propellant combinations (i.e. fuels) used in rocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; Brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units. **08 Hrs**

Text Books:

1. R. Yadav, *"Thermodynamics & Heat Engines",* Central Publication House-Allahabad, 2011.
2. D. S. Kumar and V. P. Vasandani*, "Heat Engineering",* S.K. Kataria& Sons; Reprint, 2013.

3. J. S. Rajadurai , "*Thermodynamics and Thermal Engineering"* New Age International (P) Ltd. Publishers, 1st Edition 2003, Reprint 2015.
4. S.M. Yahya, *"Turbines, Compressors and Fans"*, McGraw Hill Education (India), Chennai,4th Edition,2017.
5. P.L.Ballaney*," Thermal Engineering"*, Khanna Publishers, New Delhi, 2005.

Reference Books:

1. Jack D. Mattingly, *"Elements of Gas Turbine Propulsion",* McGraw Hill Education (India), Chennai, 6th Edition, 2013.
2. H. Cohen, G. F. C. Rogers and M. Sarvan,*"Gas Turbine Theory",* Pearson Education Canada; 5th Edition, 2008.
3. Heinz P. Bloch, *"Steam Turbines: Design, Applications, and Rerating"*, McGraw-Hill Professional, 2nd Edition,2009. (E-Book available)

Topics for Self Learning (TSL)
1. ***Air Compressors:*** *Applications of various compressors according to working.*
2. ***Reciprocating Air Compressors****: Study of lubricants that can be used for cooling medium.*
3. ***Rotary compressors:*** *Troubleshooting in air compression.*
4. ***Steam Turbines****: Corrosion and erosion of steam turbine blades and its remedies.*
5. ***Gas Turbines****: Causes for Failure of gas turbine blades*.

Subject Code:BSME-101 **Subject Name: Mathematics III**

Programme:B.Tech. (ME)	**L:** 3 T: 1 P: 0
Semester:4	**Teaching Hours:** 40
Theory/Practical: Theory	**Credits:**4
Internal Marks:40	**Percentage of Numerical/Design/Programming Problems:**90%
External Marks:60	**Duration of End Semester Exam (ESE):** 3hr
Total Marks:100	**Course Status:** Compulsory

Prerequisites: Knowledge of partial differentiation, probability and statistics.
Additional material allowed in ESE: Scientific calculator, log tables, probability distribution tables, statistical tables, etc.
On completion of the course, student will have the ability to:

CO#	Course Outcome (CO)
1.	Understand Partial Differential Equations and their solutions techniques.
2.	Infer the solution of several engineering problems involving one dimensional wave and heat equation , Laplace equation
3.	Evaluate the derivative and integration of functions of complex variable.
4.	Analyze probability spaces, random variables and bivariate distributions.
5.	Formulate and solve problems involving random variables.
6.	Apply statistical methods for analyzing experimental data.

Detailed Content:

Part-A

1. **Partial Differential Equations and Applications:**First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification.Solution of the wave equation, heat equation and Laplace equationsolutions using separation of variables. **12 Hrs**
2. **Probability Distributions:**Probability spaces, conditional probability, independence; Discrete random variables, Poisson and binomial distribution. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule. **08Hrs**

Part-B

3. **Complex Variables**: Cauchy-Riemann equations, analytic functions,elementary analytic functions (exponential, trigonometric, logarithm) and their properties, harmonic functions, finding harmonic conjugate. Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof) Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine. Conformal mappings, Mobius transformations and their properties. **12 Hrs**
4. **Statistics**: Measures of Central tendency: Moments, skewness and Correlation and regression – Rank correlation. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.Smallsample test for single mean and difference of means, test for ratio of

variances - Chi-square test for goodness of fit and independence of attributes.
08Hrs

Textbooks:

1. Erwin Kreyszig, *"Advanced Engineering Mathematics"*, 9th Edition, John Wiley & Sons, 2006.
2. N.P. Bali and Manish Goyal, *"A text book of Engineering Mathematics"*, Laxmi Publications, Re-print, 2010.
3. B.S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publishers, 36th Edition, 2010.
4. B.V Ramana., *"Higher Engineering Mathematics",* Tata McGraw Hill, 11th Reprint, 2010.

Reference books:

1. P. G. Hoel, S. C. Port and C. J. Stone, *"Introduction to Probability Theory"*, Universal Book Stall, 2003 (Reprint).
2. S. Ross, *"A First Course in Probability"*, Pearson Education India, 6th Edition, 2002.
3. J. W. Brown and R. V. Churchill, *"Complex Variables and Applications"*, Mc-Graw Hill, 7th Edition, 2004.
4. G.B. Thomas and R.L. Finney, *"Calculus and Analytic geometry"*, Pearson, Reprint, 9th Edition,2002.

Subject Code: PCME-108 **Subject Name: Fluid Mechanics and Machinery**

Programme: B.Tech.(ME**)**	**L:** 3 **T:** 1 **P:** 0
Semester: 4	**Teaching Hours:** 40
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 50%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the structure and properties of the fluid.
2	Understand the concept and solve problems related to statics, kinematics and dynamics of fluids.
3	Use and apply dimensional analysis techniques to various physical fluid phenomena.
4	Analyze the viscous flow through pipe flow and determine head loss in pipe network.
5	Recognize basic components of turbo machines and understand related fundamental laws/ principles and apply these for calculation of various parameters like work done, force efficiency etc.
6	Understand constructional details, working and design aspects of runner/wheel and evaluate the performance of various turbines like Pelton, Francis, Kaplan, Centrifugal and Reciprocating pump.

Detailed Contents:

PART-A

1. **Basic Concepts and Properties:**Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges. **06 Hrs**
2. **Fluid Kinematics and Fluid Dynamics:**Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net – fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturimeter, Orifice meter, Pitot tube - dimensional analysis - Buckingham's theorem- applications - similarity laws and models. **09 Hrs**

PART-B

3. **Incompressible Fluid Flow:**Viscous flow - Navier - Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's)- Hydraulic and energy gradient - flow through pipes - Darcy - weisback's equation - pipe roughness -friction factor - Moody's

diagram-minor losses - flow through pipes in series and in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients. **10 Hrs**

4. **Hydraulic Turbines**:Euler's equation for turbo machines - Construction of velocity vector diagram's - head and specific work - components of energy transfer - degree of reaction.Hydro turbines: definition and classifications - Pelton turbine - Francis turbine - propeller turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies -performance curve for turbines.

   10 Hrs

5. **Hydraulic Pumps:** Pumps: definition and classifications - Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram and work saved by air vessels and performance curves - cavitations in pumps. **05 Hrs**

TEXT BOOKS

1. D.S.Kumar, *"Fluid Mechanics and Fluid Power Engineering"*, S K Kataria and Sons, 2016.
2. F.M.White,*"Fluid Mechanics"*, Tata McGraw-Hill, 5th Edition, New Delhi, 2003.
3. JagdishLal, *"Hydraulic Machines"*, Metropolitan Book Co.Pvt Ltd.-New Delhi; 6th Edition, 2016.
4. Y.A. Cengel and J.M. Cimbala, *"Fluid Mechanics - Fundamentals and Applications",* Tata McGraw Hill Publications, 3rd Edition, 2013
5. S.K.Som, and G. Biswas, *"Introduction to Fluid Mechanics and Fluid Machines"*, Tata McGraw-Hill, 2nd Edition, 2004.

Reference Books

1. V.L. Streeter, and E.B.Wylie, *"Fluid Mechanics",* McGraw-Hill, 1983.
2. I.G. Curie, *"Fundamentals of Fluid Mechanics"*,CRC Press; 4th Edition, 2016.
3. Mahmoud Galal El-Din Mohamed Rabi, *"Fluid Power Engineering"*,McGraw-Hill Professional,2009,(E-Book Available)

Subject Code: PCME-109 Subject Name: Modern Manufacturing Processes

Programme: B.Tech.(ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: Manufacturing Technology

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the concept of latest technologies and Non Traditional machining processes needed for manufacturing of components.
2	Select suitable technology or process for stringent requirement of manufacturing industry.
3	Describe and demonstrate the constructional features of machines/set ups related to major nonconventional machining.
4	Analyze the effect of process parameters on performance of major non-conventional machining.
5	Understand the concepts related to hybridization of modern machining processes and their utilization in industry.
6	Use various additive manifesting processes according to industrial requirements.

Detailed Contents:

Part – A

1. **Introduction:** Latest trends in Manufacturing; Introduction to Flexible manufacturing system; Introduction to computer integrated manufacturing; Development of Non-conventional manufacturing processes. **04Hrs**
2. **Modern Manufacturing Processes:** Modern Machining Processes: Mechanical Processes: Basics of Ultrasonic machining, Water Jet Machining and Abrasive Flow Machining; Applications and limitations. Electrochemical & Chemical Removal Processes: Principle of operation; elements and applications of Electrochemical Machining; Electro-chemical grinding; Electro-chemical honing; chemical machining. Thermal Metal Removal Processes: Electric Discharge Machining- Mechanism of metal removal; electrode feed control; selection of electrode material; applications. Plasma Arc Machining- Mechanism of metal removal; PAM parameters and applications.Laser Beam machining- Material removal; limitations and advantages.Electron-Beam Machining-; Generation and control of electron beam; process capabilities and limitations. Hybrid Machining Processes: Concept; classification; application; Advantages. **14 Hrs**

Part - B

3. **Modern Welding Processes:** Principle, Equipment and Constructional details: Electron Beam Welding, Laser Beam Welding, Ion Beam Welding, Plasma welding, Thermit Welding, Electro slag and Electro gas Welding. Ultrasonic welding; Cold Metal Transfer technology; Friction stir Welding; Regulated Metal Deposition Process; Adhesive Bonding; Additive Manufacturing by welding. **07 Hrs**
4. **Modern casting Processes:** Evaporative Casting Process, investment, Shell Mold Casting, ceramic shell mould Vacuum molding, hot box, cold box casting process, full mould process, die casting,centrifugal casting. **05 Hrs**
5. **Modern Forming Processes:** High Energy Rate Forming Methods (HERF) Comparative Study of Conventional and High Velocity Forming of Metals, Review of Theory of plasticity, Principle, Process Parameters, equipment & mechanics of explosive forming, electro-hydraulic forming, magnetic pulse forming, Application of HERF Techniques. **05 Hrs**
6. **Additive manufacturing:** Introduction, advantages, limitations, and applications; Methods of producing metal powders, briquetting and sintering; Introduction to Selective Laser Melting and Selective Laser Sintering; 3-D Printing; Rapid prototyping and rapid tooling**.** **05Hrs**

Text Books:

1. P. C Panday ,H. S. Shan,"*Modern Machining Processes*", Tata McGraw Hill , 33rd Reprint , 2008.
2. AmitabhaGhosh and Asok Kumar Malik, "Manufacturing Science", Pearson Publications, 2ndEdition,2010.
3. SeropeKalpakjian and Steven R. Schmid*, "Manufacturing Engineering and Technology",* Pearson Publishers, 4th Edition, 2002.
4. V.K. Jain, "*Advanced Machining Processes*", Allied Publishers, 1stEdition, 2007.
5. Abdel Hassan, El-HofyGawad, "*Fundamentals of Machining Processes: Conventional and Nonconventional Processes*", Taylor& Francis, 2014.

Reference Books:

1. Amithaba Bhattacharyya, *"New Technology",* The Institution Of Engineers, India
2. HMT Bangalore, *"Production Technology"*, Tata McGraw–Hill Publishing Company Limited, New Delhi, 2006.

Subject Code: LPCME-104 **Subject Name: Theory of Machines Laboratory**

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 4	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 2hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Conceptualize the function and applications of kinematic chains, mechanisms.
2	Calculate coefficient of friction for different types of belt-pulleys and material combinations.
3	Understand the function of gears and evaluate gear train value of different gear trains.
4	Determine magnitude and position of balancing mass for unbalanced rotating parts.
5	Create the profile of cam with various followers and pressure distribution profile of journal bearings.
6	Compare the function of governors and flywheels to control the engine speed.

Special Instruction related to resources requirement: Nil

Sr.No.	Name of Practical
1.	To fabricate various inversions of the kinematic chains.
2.	To draw displacement, velocity & acceleration diagrams of single slider/double slider crank & four bar mechanism by using working models.
3.	To determine coefficient of friction for a belt pulley material combination.
4.	To demonstrate various types of gears.
5.	To perform the balancing of rotating masses.
6.	To analyse the profile of a cam with various followers.
7.	To determine gear train value of compound gear trains &epicyclic gear trains.
8.	To draw circumferential & axial pressure profile of journal bearing.
9.	To conduct experiments on various types of governors & to co-relate equilibrium height & speed of the governor.
10.	To determine moment of inertia of a fly wheel.

R**eference Material**

Manuals available in Lab.

Subject Code:LPCME-105 Subject Name: Applied Thermodynamics Laboratory

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 4	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 1hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Thermodynamics

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Identify different types of IC engines and their parts; understand construction & working of IC engines.
2	Understand impact of valve timing on performance of IC engines.
3	Demonstrate the construction and working of different types of steam generators and their parts.
4	Evaluate the performance of steam generators.
5	Evaluate the performance of IC engines.
6	Demonstrate the construction and working of power plant parts like condensers.

Sr.No	Name of Practical
1.	Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models.
2.	To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine.
3.	Study working construction of various boilers (Cochran, Lancashire, Babcock and Wilcox, Benson, Lamont, once through boiler tower type).
4.	Study of working, construction, mountings and accessories of various types of boilers.
5.	To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.
6.	Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line.
7.	Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test).
8.	Performance testing of a diesel engine from no load to full load (at constant speed) for a single cylinder/ multi-cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the smoke density. Draw/obtain power consumption and exhaust emission curves. Also, make the heat balance sheet.
9.	Performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi-cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption and to measure the exhaust emissions. Also, draw/obtain power consumption and exhaust emission curves.
10.	Study of construction and operation of various types of steam condensers and cooling towers.

R**eference Material:**

Manuals available in Lab.

Subject Code:LPCME-106 Subject Name: Fluid Mechanics & Machinery Laboratory

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 4	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 1hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites:

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Understand different concept of continuity equation and flow rate.
2	Analyze different form of energies in fluid flow and inter conversion.
3	Distinguish various types of flows and flow measurement methods.
4	Calculate the head losses associated with friction and pipe fittings
5	Suggest installations of hydraulic turbine depending on different requirements.
6	Understand working of various types of pumps and remedial solutions for different faults.

Sr.No.	Name of Practical
1.	To determine the meta-centric height of a floating vessel under loaded and unloaded conditions.
2.	To study the flow through a variable area duct and verify Bernoulli's energy equation.
3.	To determine the discharge coefficient for a venturi meter.
4.	To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.
5.	To determine the discharge coefficient for a V- notch or rectangular notch.
6.	To determine the friction coefficients for pipes of different diameters.
7.	To draw performance /characteristics curves of Pelton turbine/ Francis Turbine.
8.	To draw performance/ characteristics curves of Centrifugal pump/reciprocating pump.

R**eference Material**

Manuals available in Lab.

Subject Code:LPCME-107 Subject Name: Modern manufacturing process Laboratory

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 4	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 1hr
Total Marks: 50	**Course Status:** Compulsory

Prerequisites:

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Understand the concepts of CNC machine tools, their types and features
2	Generate part programs using CNC programming and simulation.
3	Evaluate the performance of drilling by CNC drill machine.
4	Understand the concept of additive manufacturing.
5	Understand the performance of EDM.
6	Evaluate the performance of electrochemical machine.

Sr.No.	Name of Practical
1.	Study the characteristics of various CNC machines on swansoft simulator.
2.	Machining practice on CNC milling trainer
3.	Practice on single axis CNC Drilling machine.
4.	Study the performance characteristics of electrical discharge machining process
5.	Demonstration the working of 3D Printer machine.
6.	Machining practice on electrochemical machine.

R**eference Material**

Manuals available in Lab.

Subject Code: PCME-110 **Subject Name: Finite Element Method**

Programme: B. Tech. (ME)	**L:** 2 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 24
Theory/Practical: Theory	**Credits:** 2
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 70%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Differentiate between various analysis methods and apply general analysis algorithm.
2	Formulate the governing equations required to state the problem in mathematical terms.
3	Understand the concepts of nodes and coordinate system.
4	Derive the shape function for the various elements and apply them.
5	Solve the equations formed in analysis procedure using different methods.
6	Analyse the problem of body like bar, truss, frame with FEM.

Detailed Contents

Part-A

1. **Introduction:** General description of the method; Brief history of FEM, FEM v/s Classical Method; FEM v/s FDM, Brief explanation of FEA for a Stress Analysis Problem. **02 Hrs**
2. **Matrices:** Eigen value and problem; Matrix displacement equations; Solution of matrix displacement equations. **02 Hrs**
3. **Basic Equations in Elasticity:** Equations of equilibrium; Strain displacement equations; Linear constitutive law. **02 Hrs**
4. **Nomenclature of Finite Elements:** Element shapes; Nodes; Nodal unknowns; Coordinate systems; Types of element –Isoparametric, Sub parametric, Super parametric. **03 Hrs**
5. **Shape Functions:** Introduction - Polynomial shape functions; Convergence requirements of shape functions; Derivation of shape functions using polynomials; Finding shape functions using Lagrange polynomials. **04 Hrs**

Part -B

6. **Strain Displacement Matrix and Assembling Stiffness Equation:** Strain displacement matrix for bar; Assembling stiffness equation by - Direct approach, Galerkin's method and Virtual work method. **05 Hrs**
7. **Finite Element Analysis – Bars, Trusses:** Tension bars/columns; Two dimensional trusses. **03 Hrs**
8. **Finite Element Analysis – 2 Dimensional problems:** Constant strain triangle, Plane Stress and Plane Strain problems. **03 Hrs**

Text Books

1. D. L. Logan, "*A First Course in the Finite Element Method*", CL Engineering, 6th Edition, 2017.
2. T. R. Chandrupatla, Ashok D. Belegundu, "*Introduction to Finite Element in Engineering*", Pearson Publications, 4th Edition 2012.
3. R. D. Cook, D. D. Malkus, M. E. Plesha and R. J. Witt, "*Concepts and Applications of Finite Element Analysis*", John Wiley Publications, 4th Edition. 2002.
4. Klaus-Jurgen Bathe, "*Finite Element Procedures in Engineering Analysis*", Prentice Hall, 2nd Edition, 2014.
5. D. D. Hutton, "*Fundamental of Finite Element Analysis*", McGraw Hill Publications, 1st Edition, 2003.

Reference Books

1. Y. W. Kwon, "*The Finite Element Method using MATLAB*", Boca Raton, FL: CRC Press 2nd Edition, 2000.
2. M. G. Larson, "*Finite Element Method: Theory, Implementation, and Applications*", New York: Springer, 1st Edition, 2006.
3. Chandrakant S. Desai, Tribikram Kundu, *"Introductory Finite Element Method"* CRC Press 1stEdition, 2001.

E-Books and online learning material

1. Finite Element Procedures by Klaus-Jurgen Bathe Accessed on April, 2020
   http://web.mit.edu/kjb/www/Books/FEP_2nd_Edition_4th_Printing.pdf
2. Fundamental of Finite Element Analysis by David V. Hutton Accessed on April, 2020
   http://research.iaun.ac.ir/pd/atrian/pdfs/UploadFile_2613.pdf

Online Courses and Video Lectures

1. https://nptel.ac.in/courses/112104116/ Accessed on April, 2020
2. https://nptel.ac.in/courses//112104193/ Accessed on April, 2020

Subject Code: PCME-111 **Subject Name: Design of Machine Elements**

Programme: B. Tech.(ME**)**	**L:** 3 **T:** 1 **P:** 0
Semester: 5	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 80%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA

Additional Material Allowed in ESE:

1. Non programmable Scientific Calculator is allowed.
2. Design Data Book, PSG College of Engineering and Technology, Coimbatore, Revised Edition, 1978, Reprint in 2010.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand various types of design and criteria for selection of materials for different applications.
2	Apply various design considerations like stress concentration factor and factor of safety.
3	Understand various basic machine components under different loading conditions.
4	Analyse the fastening processes like bolting, welding, riveting etc. for different applications.
5	Evaluate machine members like transmission drives, levers, shafts, axles, keys, coupling and cotters etc. as per different requirements in the industry.
6	Create the design and suggest/apply suitable modifications in the design

Detailed Contents:

Part-A

1. **Introduction:** Meaning of design with special reference to machine design; Definition and understanding of various types of design; Design process; Design and Creativity; General Design Considerations; Concept of - tearing, bearing, shearing, crushing, bending and fracture; Designation of materials according to Indian standards code number 1570 (Part II/Sec I)-1979 (Reaffirmed 1991); Basic criteria for selection of materials; Mechanical properties of materials. **03 Hrs**
2. **Design Considerations**: Concept of concurrent engineering in design; Manufacturing and Ergonomic considerations in Machine Design; Stress concentration; Factor of Safety under different loading conditions; Design for static loading; Design for variable loading for both limited and unlimited life; Concept of Fatigue and Endurance Strength. **07 Hrs**
3. **Design of Keys and Couplings**: Design of keys; Design of splines; Design of - sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling; Design of universal joint. **06 Hrs**

Part-B

4. **Design of Fasteners:** Design of bolted joints; Design of rivets for boiler joints, lozenge joints; eccentrically loaded riveted joints; Design of - spigot and socket cotter joint, gib and cotter joint , knuckle joint; Design of welded joints for various loading conditions such as torsion, shear, direct and eccentric loading. **07 Hrs**
5. **Design of Transmission drives:** Design of - flat belt, rope, chain and spur gear drive; Design of solid and hollow shafts for transmission of torque, bending moment & axial forces; Design of shaft for rigidity. **07 Hrs**
6. **Design of Levers**: Design of - foot lever, hand lever, cranked lever, bell crank lever, safety valve lever and shoe brake lever. **06 Hrs**

Text Books

1. Joseph E. Shigley, Mischke Charles Russell, Richard Gordon Budynas, "*Mechanical Engineering Design*", McGraw-Hill, 8th Edition, 2006.
2. R. S. Khurmi, J. K. Gupta, "*Machine Design*", S.Chand and Co.,1st Multicolor Edition , 2014
3. Robert C. Juvinall, "*Fundamentals of machine component design*", John Wiley & Sons, 3rd Edition, 2003.
4. P.C. Sharma, D. K. Aggarwal, "*Machine Design*", S. K. Kataria and Sons, 9th Edition, 1999.
5. V. B. Bhandari, "*Design of Machine elements*", Tata McGraw Hill, 3rd Edition, 2010.

Reference Books

1. Jack A. Collins, Henry R. Busby, George H. Staab, "*Mechanical Design of Machine Elements and Machines*", John Wiley & Sons, 2009.
2. T. Krishna Rao, "*Design of Machine Elements: Volume II*", I. K. International Pvt Ltd, 2010.
3. Peter R.N. Childs, "*Mechanical Design Engineering Handbook*", Elsevier Ltd., 2nd Edition, 2019.

Subject Code: PCME-112 **Subject Name: Heat Transfer**

Programme: B. Tech.(ME**)**	**L:** 3 **T:** 1 **P:** 0
Semester: 5	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 80%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Recognize the predominant mode of heat transfer in various engineering applications.
2	Analyze the various heat transfer problems (mainly one dimensional under steady state condition) using basic laws of heat transfer and electrical analogy.
3	Develop mathematical relations to solve heat transfer problems.
4	Select and design the fins for various engineering applications.
5	Apply the basic laws of radiation and electrical network analysis to solve radiative heat exchange problems.
6	Design the heat exchangers by using the concept of conductive and convective (simple and phase change) heat transfer phenomenon.

Detailed Contents:

Part-A

1. **Introduction**: Concept of heat transfer; Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics"; Different modes of heat transfer –Conduction, Convection and Radiation. **02 Hrs**
2. **Conduction**: Fourier's law of heat conduction; Coefficient of thermal conductivity; Effect of temperature and pressure on thermal conductivity of solids, liquids and gases; Three dimensional general conduction equations in rectangular, cylindrical and spherical coordinates; Deduction of one dimensional steady state heat conduction equation in rectangular, cylindrical and spherical coordinates with and without internal heat generation for uniform thermal conductivity of material; Concept of variable thermal conductivity; Electrical network analysis for heat transfer through composite/multilayer material. **07 Hrs**
3. **Application of Conduction Heat Transfer**: Application of heat conduction with internal heat generation in case of piston crown and in nuclear fuel rod with/ without cladding; Concept of equivalent area; Conduction shape factor; Conduction through edges and corners of walls; Critical thickness of insulation layers on electric wires and pipes carrying hot fluids; Introduction to unsteady heat transfer; Newtonian heating and cooling of solids; Physical significance of thermal diffusivity. **05 Hrs**
4. **Theory of Fins**: Concept of fin; Classification of fins and their applications; Straight fins of uniform cross-section and varying cross-sectional area (triangular/trapezoidal profile); Circumferential fins of rectangular cross-section; Fin performance: fin effectiveness, fin

efficiency, total fin effectiveness and total fin efficiency; Application of fins in temperature measurement of flow through pipes and determination of error in its measurement. **03 Hrs**

Part-B

5. **Convection**: Free and forced convection; Derivation of three-dimensional mass, momentum and energy conservation equations (Vector and Tensor form); Boundary layer formation: Laminar and Turbulent boundary layers (no derivation); Determination of heat transfer coefficient for free and forced convection by dimensional analysis method; Physical significance of dimensionless numbers related to convective heat transfer; Use of analytical/empirical formulae for convective heat transfer in laminar and turbulent flow over vertical and horizontal plate, cylinder / pipe and sphere; Newton's law of cooling; Overall coefficient of heat transfer; Different design criterion for heat exchangers; Log mean temperature difference (LMTD) for parallel and counter flow heat exchangers; Calculation of length and number of tubes in a heat exchanger using LMTD and effectiveness-NTU method. **08 Hrs**
6. **Convection with Phase Change (Boiling and Condensation)**: Boiling - definition and types of boiling, Different regimes and heat transfer during pool boiling of a liquid, Nucleation and different theories accounting for increased h.t.c. during nucleate phase of boiling; Condensation - definition and types of condensation, film wise condensation on a vertical and inclined surface. **04 Hrs**
7. **Radiation**: Process of heat flow due to radiation; Definition of emissivity, absorptivity, reflectivity and transmissivity; Concept of black and grey bodies; Plank's law of non chromatic radiation; Wien's displacement law; Kirchoff's law; Stefan Boltzmann's law; Lambert's Cosine law; Definition of intensity of Radiation (only), irradiation, radiation density and radiosity; Geometric/ configuration factor and its use in heat exchange between two black bodies; Electrical network analysis for radiation exchange between two, three or four bodies (e.g. boiler or other furnaces); simplification of electrical network analysis for its application to simple bodies like two parallel surfaces, concentric cylinders/spheres and a body enveloped by another body etc.; Use of radiation shields. **07 Hrs**

Text Books

1. F.P. Incropera and D.P. De Witt, *"Fundamentals of Heat and Mass transfer",* John Wiley, 7th Edition, 2011.
2. A. Yunus Cengel, *"Heat and Mass Transfer",* Tata McGraw Hill Education Private Ltd, 4thEdition, 2013.
3. D.S. Kumar, *"Fundamentals of Heat and Mass Transfer",* S K Kataria & Sons, 7th Edition, 2013.
4. A. J. Chapman, *"Heat Transfer",* McGraw Hill, 7th Edition, 1990.
5. J.P. Holman, *"Heat Transfer"*, Tata McGraw-Hill Publishing Company Ltd, 9th Edition, 2008.

Reference Books

1. Warren M. Rohsenow, James P. Hartnett and Young I. Cho, "*Handbook of Heat Transfer*" Tata McGraw-Hill Publishing Company Ltd, 3rd Edition, 1998

2. R.C. Sachdeva, "*Fundamentals of Engineering Heat & Mass transfer*", New Age International Publishers, 2009
3. P.K. Nag, "*Heat Transfer*", Tata McGraw Hill, New Delhi, 2002.

Subject Code: HSMME-101 **Subject Name: Operation Research**

Programme: B. Tech. (ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 80%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA
Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the characteristics of different types of operations research models in real-life environments.
2	Application of different types of deterministic and probabilistic models in finding real-life environments.
3	Design new simple models, like CPM, to improve decision making.
4	Implement the various OR tools for better decision making.
5	Identify and apply the appropriate operation research model.
6	Apply the Solver toolbox for getting quick results.

Detailed Contents:

Part-A

1. **Introduction**: Origin of OR and its role in solving industrial problems; General approach for solving OR problems; Classification of mathematical models; various decision-making environments. **03 Hrs**
2. **Deterministic Models**: Formulation of deterministic linear mathematical models - Graphical and simplex techniques for the solution of linear programming problems, Big M method; Introduction to duality, duality theorem and sensitivity analysis. **06 Hrs**
3. **Transportation Models:** North-west corner rule, Row minima method, Column minima method, Least cost method and Vogel approximation method (VAM), Optimization of transportation problem using Stepping stone and MODI method **04 Hrs**
4. **Assignment, Sequencing Models and Game Theory:** Hungarian method/algorithm, Optimization of assignment problem, Johnson rule; Solution of simple two-person zero-sum games. **05 Hrs**

Part-B

5. **Dynamic Programming**: Introduction to deterministic and probabilistic dynamic programming; Solution to simple problems. **03 Hrs**
6. **Queuing theory:** Types of the queuing situation; Queuing models with Poisson's input and exponential service, their application to simple situations. **05 Hrs**
7. **Network models:** Shortest route and traveling salesman problems; PERT & CPM Introduction; Analysis of time-bound project situations; Construction of networks;

Identification of critical path; Slack and Float; Crashing of a network for cost reduction; Resource leveling and smoothening. **07 Hrs**

8. **Solving LPs using Solver:** Setting up the problem and solving simple LP problems; Transportation problems and Assignment problems. **03 Hrs**

Text Books:

1. P. K. Gupta and D. S. Hira, *Operations Research*, S. Chand Limited, India, 2008.
2. D. M. Miller, and J. W. Schmidt, *Industrial Engineering and Operations Research*, John Wiley & Sons, Singapore, 1990.
3. H. A. Taha, *Operations Research*, Pearson, 2004.
4. R. Paneerselvam, *Operations Research,* Prentice Hall of India, New Delhi, 2008.
5. G. Srinivasan, *Operations Research-Principles and Applications*, PHI Pvt. Ltd., 2010.
6. MS Excel Tool Box for Solver

Reference Books:

1. P. Ramamurthy, *Operations Research*, New Age International (P) Limited, 2007.
2. R. Pannerselvam, *Design and Analysis of Algorithms*, Prentice Hall of India, New Delhi, 2007.
3. A. P. Verma, *Operations Research*, S.K. Kataria & Sons, 2013.

E-Books and online learning material

1. Operations Research - A Model-Based Approach by H. A. Eiselt, Carl-Louis Sandblom, Springer Texts in Business and Economics

   https://www.kobo.com/us/en/ebook/operations-research Accessed in June 2020

2. Introduction to Operations Research- Deterministic Models by Juraj Stacho

   https://www.cs.toronto.edu/~stacho/public/IEOR4004-notes1.pdf Accessed in June 2020

Online Courses and Video Lectures

1. https://nptel.ac.in/courses/112/106/112106134/ Accessed in June 2020
2. https://nptel.ac.in/courses/112/106/112106131/ Accessed in June 2020
3. https://nptel.ac.in/courses/110/106/110106059/ Accessed in June 2020

Subject Code: PCME-113 **Subject Name: Mechanical Measurement and Control**

Programme: B. Tech.(ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA

Additional Material Allowed in ESE: NIL

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand the concept of measurements and measurement standards used in industrial applications.
2	Apply the concept of static and dynamic characteristic of a measuring instrument.
3	Evaluate various errors in measuring systems by using statistical methods.
4	Understand the functions of sensors and transducers for their utility in instrumentation.
5	Use the instruments for measurements of pressure, flow, temperature etc. in manufacturing or process industry.
6	Analyze various control systems.

Detailed contents

Part – A

1. **General Concepts and Characteristics of Instruments:** Need and classification of measurements and instruments; Basic and auxiliary functional elements of a measurement system; Methods of measurement; Mechanical versus Electrical /Electronic instrument; Measuring Standards- primary, secondary and working standards, calibration standards; Static and Dynamic characteristics of Instruments - range and span, accuracy and precision, hysteresis, dead zone, dead time sensitivity and linearity, threshold and resolution, speed of response, lag, fidelity and dynamic error; Zero order system, First order systems. **05 Hrs**
2. **Errors in Measurement:** Types of errors - gross, systematic, random errors; Sources of error; statistical analysis of test data - statistical averages, dispersion of mean, normal curve of errors, confidence interval and confidence level. **03 Hrs**
3. **Metrology**: Standards of measurement - line, end and wavelength standards; Linear measurements; Comparators - features, types of comparators; Angular measurements; Sine Bar and Sine Table , Clinometers - types, Autocollimator; Concept and measurement of straightness and flatness by interferometer; Surface roughness - specifications and measurement; Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form for internal and external threads; Measurement of tooth thickness, pitch and checking of profile for spur gears. **06 Hrs**
4. **Functional Elements:** Introduction to sensors and transducers - types of sensors, review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pickups, photo cells and piezoelectric transducers and application of these elements in measurement; Resistance strain gauges, application of strain gauges. Introduction to amplifying transmitting and recording devices. **04 Hrs**

Part – B

5. **Pressure and Flow Measurement:** Sensing Elements - Bourdon tube, Capsules, Diaphragm and bellows; Vacuum measurement –McLeod gauge, Thermal conductivity gauge and Ionization gauge; Dead weight gauge tester. Electromagnetic flux meters; Ultra-sonic flow meters and Hot wire anemometer. Flow visualization techniques. **05 Hrs**
6. **Temperature Measurement**: Thermal expansion methods- Bimetallic thermometers, Liquid in-glass thermometer and Filled-in-system thermometers; Common thermo couples, Metal Resistance Thermometers and Thermistors; Total and Optical Radiation Pyrometers. **04 Hrs**
7. **Speed; Force; Torque and Shaft Power Measurement**: Mechanical tachometers; vibration reed tachometer and stroboscope; Proving ring; hydraulic and pneumatic load cells; Measurement of torque - Absorption and Transmission dynamometers. **04 Hrs**
8. **Introduction to control systems**: Classification of control systems - open loop and closed loop control system, Automatic control systems; Properties of the transfer function, Representation of control components and systems; Regulator, Servo mechanism, Analogous systems; Block diagram; Signal flow graph; Time response of control system; Stability; Frequency response; Error detector; LVDT; Servo amplifier; Sample data systems; Industrial controllers; Pneumatic control systems, Hydraulic control system. **05 Hrs**

Text Books:

1. E. O. Doebelin, "*Measurement System: Application and Design*", McGraw- Hill, 5th Edition, 2008.
2. N.V. Raghavendra, L. Krishnamurthy, "*Engineering Metrology and Measurements*", Oxford University Press, 2013.
3. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, "*Mechanical Measurements*" , Pearson Prentice Hall, 6th Edition, 2007
4. R. K. Rajput, "*Mechanical Measurements and Instrumentation*", S.K. Kataria Publishers, 2nd Edition, 2012.
5. B. C. Nakra, K. K. Chaudhry, "*Instrumentation, Measurement and Analysis*", Tata Mc-Graw Hill, 2nd Edition, 2006.

Reference Books:

1. Alan S. Morris, "*The Essence of Measurement*", Prentice Hall of India, 1996.
2. A. Bewoor and V. Kulkarni, "*Metrology and Measurement*", McGraw-Hill, 1st Edition, 2009.
3. E. O. Doebelin and N. K. Manik , "*Measurement Systems*" , McGraw-Hill, 7th Edition (SIE), 2019.

Subject Code: PCME-114 **Subject Name: Industrial Automation and Robotics**

Programme: B. Tech.(ME**)**	**L:** 3 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits: 3**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the concept, need and application of hard automation, soft automation and their advantages.
2	Use the hydraulic and pneumatic valves and cylinders for their application in automation.
3	Design the pneumatic and hydraulic circuits for industrial automation applications.
4	Analyze the working of fluidic sensors for industrial applications.
5	Understand the working of various transfer devices and feeders in manufacturing industry.
6	Create a programme of robotic arm for industrial application.

Detailed Contents:

Part-A

1. **Introduction**: Concept and scope of automation; Socio-economic impacts of automation; Types of automation; Low cost automation. **02 Hrs**
2. **Fluid Power**: Fluid power control elements; Standard graphical symbols; Hydraulic and pneumatic cylinders- Construction; Design and Mounting; Hydraulic and pneumatic Valves for pressure; Flow and direction control. **03 Hrs**
3. **Basic hydraulic and pneumatic circuits**: Direct and indirect control of single and double acting cylinders; Designing of logic circuits for a given time displacement diagram & sequence of operations; Design of simple hydraulic and pneumatic circuits using - time delay valve, quick exhaust valve etc.; Speed control of a cylinder; Trouble shooting - causes & effects of malfunctions; Designation of specific elements in a circuit; Different types of sensors for hydraulic, pneumatic & electro-pneumatic systems. **07 Hrs**
4. **Fluidics**: Boolean algebra, commutative law and distributive law; Truth tables and logic gates- AND gate, OR gate, XOR gate, NAND gate, NOR gate, NOT gate, XNOR gate; Fluidic devices; Coanda effect; Fluidic sensors and fluidic amplifiers - Construction; Working and Applications. **06 Hrs**

Part-B

5. **Electrical and Electronic Controls**: Basics of programmable logic controllers (PLC) architecture and components of PLC; Ladder logic diagrams. Microprocessor – Introduction, structure of micro-controller. **06 Hrs**

6. **Manufacturing system and material handling technologies**: Automated production lines and their applications; Group technology; Flexible manufacturing system; Automated assembly systems; Classification, constructional details and applications of Transfer devices; Vibratory bowl feeders; reciprocating tube; Centrifugal hopper feeders. **06 Hrs**
7. **Robotics**: Introduction, Classification based on geometry; control and path movement; Robot specifications, robot performance parameters, robot programming; Machine vision; teach pendants; industrial applications of robots. **06 Hrs**

Text Books

1. Mikell P. Groover, "*Industrial Robotics*", McGraw- Hill, 4th Edition 2008.
2. S. R. Majumdar, "*Pneumatic Control*", Tata McGraw- Hill, 1stEdition, 2004.
3. Craig John, "*Introduction to Robotics: Mechanics & Control*", Prentice Hall of India, 3rd Edition, 2007.
4. S. R. Deb, "*Robotic Technology and Flexible Automation*", McGraw Hill, 2nd Edition, 2010.
5. W. Bolton, "*Mechatronics*", Pearson Education, 4th Edition, 2011.

Reference books

1. M. P. Groover, *"Automation, Production Systems and Computer Integrated Manufacturing"*, 5thEdition, Pearson Education, 2009.
2. Mikell. P. Groover, *"Industrial Robotics Technology, Programming and Applications"*, McGraw Hill Co, 1995.
3. R. D. Klafter, T. A. Chmielewski, Noggin's, *"Robot Engineering: An Integrated Approach"*, Prentice Hall of India Pvt. Ltd., 1994.
4. K. S. Fu., R. C. Gonzalez, C. S. G. Lee, *"Robotics Control, Sensing, Vision and Intelligence"*, McGraw Hill Book Co., 1987.
5. J. J. Craig, *"Introduction to Robotics, Mechanics and Control"*, 3rd Edition, Pearson Education, 2004.

Subject Code: LPCME-108 Subject Name: Industrial Automation and Robotics Laboratory

Programme: B. Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 5	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):**02Hrs
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: NA

Note:

At least two practicals in the form of Lab. Project (including design and fabrication of new experimental set up; if required; or modifications/retrofitting in the existing experimental set up/s) in the topic/s related to the subject matter covered in the theory/ practicals are required to be completed within the semester by making groups of students within the class/section. The complete theoretical and experimental analyses of these concerned practicals are required to be performed. This activity has to be completed compulsory in order to inculcate the team/ group behavior among the students.

On Completion of the course, the student shall be able to:

CO#	Course Outcomes(CO)
1	Understand the concept, need and application of hard automation, soft automation and their advantages.
2	Describe the constructional features, working and use of valves and their application in industrial automation.
3	Conceptualize and design the pneumatic and hydraulic circuits for industrial automation applications.
4	Describe the construction details and working of power steering of vehicles.
5	Analyse the simple pneumatic and hydraulic and electro pneumatic circuit using simulation software.
6	Operate the robotic arm to perform basic functions.

S. No.	Name of Practical
1	Demonstration of different types of hydraulic valves, pneumatic valves and cylinders with their symbols.
2	Actuation of double acting cylinder by using hydraulic and pneumatic circuits.
3	Automating the cylinder sequence A+B+B-A- by using electro Pneumatic and PLC
4	Demonstrate the working of power steering mechanism.
5	Use of direction control valve and pressure control valves in the design of clamping devices for jigs and fixture.
6	Demonstrate the working of robotic arm and its end effectors.
7	Analysis of basic hydraulic and pneumatic, electro pneumatic circuits using simulation software.
8	Automation system for pick & place, and Sorting of Objects on Conveyor Belt using PLC.

R**eference Material**

Manuals available in Lab.

Subject Code: LPCME-109 Subject Name: Mechanical Measurement and Control Laboratory

Programme: B. Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 5	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):**02 Hrs
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: NA

Note:

At least two practicals in the form of Lab. Project (including design and fabrication of new experimental set up; if required; or modifications/retrofitting in the existing experimental set up/s) in the topic/s related to the subject matter covered in the theory/ practicals are required to be completed within the semester by making groups of students within the class/section. The complete theoretical and experimental analyses of these concerned practicals are required to be performed. This activity has to be completed compulsory in order to inculcate the team/ group behavior among the students.

On Completion of the course, the student shall be able to:

CO#	Course Outcomes(CO)
1	Understand the basics of measurements and their needs in industry.
2	Measure dimensions, angles and shaft speed.
3	Measure the surface roughness of any metallic flat surface, pipe and rod.
4	Calibrate the pressure gauge and prepare a thermocouple.
5	Measures thread elements and gear elements.
6	Measure the effective diameter of external threads.

S. No.	Name of Practical
1	Measurement of an angle with the help of sine bar.
2	Measurement of surface roughness of a machined plate and cylindrical workpiece.
3	Measurement of gear elements using profile projector.
4	Measurement of effective diameter of external threads using three wire method.
5	Measurement of thread element by tool maker's microscope.
6	Calibration of a pressure gauge with the help of a dead weight gauge tester.
7	Measurement of speed of shaft by various methods.
8	Preparation of a thermocouple for temperature measurement.

R**eference Material**

Manuals available in Lab.

Subject Code: LPCME-110 **Subject Name: Heat Transfer Laboratory**

Programme: B. Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 5	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):**02 Hrs
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: NA

Note:

At least two practicals in the form of Lab. Project (including design and fabrication of new experimental set up; if required; or modifications/retrofitting in the existing experimental set up/s) in the topic/s related to the subject matter covered in the theory/ practicals are required to be completed within the semester by making groups of students within the class/section. The complete theoretical and experimental analyses of these concerned practicals are required to be performed. This activity has to be completed compulsory in order to inculcate the team/ group behavior among the students.

On Completion of the course, the student shall be able to:

CO#	Course Outcomes(CO)
1	Design and fabricate the experimental setups related to heat transfer phenomena.
2	Measure and analyse different heat transfer parameters.
3	Apply finite difference methods to solve simple heat transfer problems.
4	Perform experimentation on fabricated Experimental Set-up.
5	Assess relevance of prominent heat transfer mode in given circumstances.
6	Simulate various Heat Transfer situations by experimental techniques.

S. No.	Name of Practical
1	Determination of thermal conductivity of: - A solid insulating material by slab method. - Powder materials by concentric spheres method / or by some transient heat transfer technique. - a metal by comparison with another metal by employing two bars when kept in series and / or in parallel under different boundary conditions. - Liquids by employing thin layer.
2	Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder / plate when kept: a) Along the direction of flow b) perpendicular to the direction of flow c) Inclined at an angle to the direction of flow
3	Plotting of the pool boiling curves for water and to determine its critical point
4	Determination of heat transfer coefficient for i) film wise condensation ii) drop-wise condensation

5	Determination of heat transfer coefficient by radiation and hence find the Stefan Boltzmann's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
6	Determination of shape factor of a complex body by an analog technique.
7	Plotting of the temperature profile and determination of fin effectiveness and fin efficiency for i) A rod fin when its tip surface is superimposed by different boundary condition like. a) Insulated tip b) Cooled tip c) Temperature controlled tip ii) Straight triangular fins of various sizes and optimization of fin proportions iii) Circumferential fins of rectangular/triangular section
8	Investigation of Fourier Law for linear conduction of heat along a simple bar.
9	To show that the illuminance of a surface is inversely proportional to the square of the distance of the surface from the light source.
10	Demonstrate the effect of flow rate variation on the performance characteristic of a concentric tube heat exchanger operating under parallel & counter flow conditions.

Reference Material

Manuals available in Lab.

Subject Code: PCME-116 Subject Name: Refrigeration and Air Conditioning

Programme: B.Tech.(ME)	**L:** 3 **T:** 1 **P:** 0
Semester: 6	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 80%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand and identify method/type of refrigeration and air conditioning systems.
2	Analyze and evaluate air refrigeration cycles and systems especially for aircraft air conditioning.
3	Analyze and evaluate vapour compression refrigeration cycle and system.
4	Identify the different refrigerants from their nomenclature and select them from environmental aspects and field of application.
5	Understand and determine psychrometric properties, evaluate various psychometric processes and calculate cooling and heating loads for different domestic, commercial and industrial conditions.
6	Design air conditioning and refrigeration systems for various applications and select their components.

Detailed Contents:

Part-A

1. **Basic Concepts:** Definition of refrigeration; Difference between refrigeration and cooling; Definition of air conditioning; Difference between refrigeration and air conditioning; Brief history of refrigeration and air conditioning; Natural and mechanical refrigeration; Applications of refrigeration and air conditioning; Definitions of refrigerant, cooling/ refrigeration load, cooling/ refrigeration effect, cooling/ refrigeration capacity, heating load, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy efficient ratio; COP of a refrigerator; and COP/EPR of a heat pump; Single phase reversed Carnot cycle and its limitations; Two phase reversed Carnot cycle and its limitations; Methods of Refrigeration; Numerical. **04 Hrs**
2. **Gas Cycle Refrigeration and Aircraft Refrigeration & Air conditioning:** Bell Coleman/ Reversed Brayton / Reversed Joule cycle and its analysis; Optimum COP and pressure ratio (No mathematical Analysis); Applications of gas cycle refrigeration; Necessity of aircraft refrigeration and air conditioning; Classification of aircraft refrigeration and air conditioning systems; Purpose of evaporative cooler; Analysis of simple/basic aircraft refrigeration and air conditioning system (with and without evaporative cooler), Boot Strap aircraft refrigeration and air conditioning system (with and without evaporative cooler), Regenerative aircraft refrigeration and air conditioning system, Reduced ambient aircraft refrigeration and air conditioning system; Dry Air Rated Temperature (DART); Comparison of different aircraft refrigeration and air conditioning systems; Numerical. **08 Hrs**
3. **Vapour Compression Refrigeration:** Vapour compression refrigeration system and its basic components; Representation of simple/ theoretical vapour compression refrigeration cycle on P-v, T-s and P-h diagrams; Dry versus wet compression; Expansion versus throttling of liquid

refrigerant; Analysis of simple/theoretical vapour compression refrigeration cycle; Introduction of P-h diagram/chart and refrigeration tables; Determination of properties of sub cooled, saturated and superheated refrigerant using saturated properties & specific heat tables, saturated & superheated properties tables, and P-h diagram; Compressor work and volumetric efficiency; Effect on performance and cooling capacity of simple/theoretical vapour compression refrigeration cycle due to change in evaporator pressure/temperature, condenser pressure/temperature, sub cooling of liquid refrigerant, super heating of suction vapours, use of liquid - vapour regenerative heat exchanger, heat exchange of vapours with compressor cylinder walls, pressure drop (wire drawing) in suction and discharge valves, pressure drop in evaporator and condenser; Representation of actual vapour compression refrigeration cycle on T-s and P-h diagrams (No mathematical analysis); use of inverter/variable refrigerant flow in vapour compression refrigeration system. Numerical. **10 Hrs**

4. **Multi-pressure Vapour Compression Refrigeration (No Mathematical Analysis):** Definition of flash gas, its advantages and disadvantages; Methods of flash gas removal: under cooler/ sub-cooler, flash tank/chamber/separator, liquid sub-cooler; Brief introduction (no mathematical analysis) to compound (multistage) compression, its advantages; Purpose of intercooling; Methods of intercooling: air intercooler, water inter intercooler, flash intercooler, flash chamber cum intercooler, liquid sub-cooler cum intercooler; Brief introduction to multiple evaporator systems; Use of individual and multiple expansion valves arrangements, with single and multiple (individual and compound) compressors; Cascade refrigeration system. **03 Hrs**

Part-B

5. **Refrigerants:** Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of an ideal refrigerant; Azeotropes; Zeotropes; Effect of moisture and oil miscibility; Refrigerants dying agents and antifreeze solution; Leak detection and charging of refrigerants; Environmental aspects of conventional and alternative refrigerants; Comparative study of commonly used refrigerants (before and after 2000) and their fields of application; Ecofriendly refrigerants and action plan to reduce ecological hazards. **05 Hrs**
6. **Air Conditioning Concepts:** Psychrometry; Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychrometric properties of moist air: Dry bulb, wet bulb and dew point temperatures, specific humidity (humidity ratio), absolute humidity, relative humidity, degree of saturation, specific enthalpy, temperature of adiabatic saturation; Psychrometric chart and its use; Adiabatic mixing of moist air streams without condensation and with condensation; Human requirement of comfort; effective temperature and comfort charts; Industrial and comfort air conditioning applications; Numerical. **06 Hrs**
7. **Psychrometric Processes:** Basic psychrometric processes; Sensible heat process; Latent heat process; Total heat process; Sensible heat factor; Evaporative cooling; Cooling with dehumidification; Heating with dehumidification; Chemical dehumidification; Psychrometric processes in air conditioning equipment : By-pass factor; Contact factor; Cooling coils, heating coils, cooling and dehumidification coils, evaporative coolers, adiabatic dehumidifiers, water injection, steam injection, air washer; Numerical. **04 Hrs**
8. **Calculations for Air conditioning Load and for Rate and state of Supply Air:** Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Room sensible heat factor, grand sensible heat factor; Apparatus dew point temperature; Rate and state of supply air for air conditioning of different types of premises for summer and winter conditions, use of effective sensible heat factor; Numerical. **08 Hrs**

Text Books

1. C.P. Arora, *"Refrigeration and Air Conditioning"*, Tata McGraw Hill, 3rd Edition, 2009.
2. S.C. Arora, S. Domkundwar and V.A. Domkundwar, *"A Course in Refrigeration and Air Conditioning",* Dhanpat Rai & Co (P) Ltd., Reprint, 2015.
3. M. Prasad, *"Refrigeration and Air Conditioning"*, New Age International (P) Ltd. Publishers, 3rd Edition, 2015.
4. R.C. Jordan and G.B. Priester,, *"Refrigeration and Air Conditioning"*, Prentice Hall of India, 2nd Edition, 1956.
5. W.F. Stoecker, *"Refrigeration and Air Conditioning"*, McGraw Hill, 2nd Edition, 1983.

Reference Books:

1. Ibrahim Dincer and Mehmet Kanoglu, *"Refrigeration Systems and Applications"*, Wiley, 2010.
2. Roy J. Dossat, *"Principles of Refrigeration"*, Pearson Education India, 2002.
3. ASHRAE Handbook
4. Carrier's Handbook

Subject Code: PCME-115 **Subject Name: Mechanical Vibrations**

Programme: B.Tech.(ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 80%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites:

Additional Material Allowed in ESE: [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
2	Understand the need and measurement of vibration in mechanical systems.
3	Calculate principal modes of vibrations.
4	Explore the suitable methods of vibration reduction and absorption.
5	Ability to determine vibratory responses of SDOF, MDOF and continuous systems
6	Create the mathematical model of a vibratory system to determine its response.

Detailed Contents:

Part-A

1. **Introduction:** Basic concept of vibration; Importance and scope; definition and terminology; representation and analysis of harmonic motions; introduction to various types of vibrations. **09 Hrs**
2. **Single Degree of Freedom Systems:**
   Undamped Free Vibrations: D' Alembert's Principle, Energy method, Rayleigh method, Newton's second law of motion and its applications in these problems; equivalent spring stiffness.
   Damped Free Vibrations: Introduction to viscous damping, under-damped, over-damped and critically damped systems and its solutions; logarithonic decrement; frequency of damped oscillations; viscous damping; Dry friction; Structural damping and Slip damping and its analysis.
   Forced Vibrations: Damped Forced Vibration Systems; Vibration isolation and transmissibility; vibration measuring instruments; Whirling of shaft. **11 Hrs**

Part-B

3. **Two Degree of Freedom Systems:** Principal modes of vibrations; natural frequencies; amplitude ratio; undamped free, damped free, forced harmonic vibration, semi-definite systems; Lagrange' equation; combined rectilinear & angular modes. Vibration absorber principle; Torsional vibration absorber, Centrifugal pendulum vibration absorber, Torsional vibration damper, untuned dry friction and viscous vibration damper. **10 Hrs**
4. **Multi-Degree Of Freedom Systems:**
   Exact Analysis: Undamped free vibrations, Influence Coefficients, Natural frequencies and mode shapes (Eigen values and Eigen vectors), orthogonal properties of normal modes.
   Approximate Analysis: Rayleigh, Dunkerley, Stodola, Holzer and Matrix Iteration methods as applied to multi degree of freedom systems. **10 Hrs**

5. **Vibration Of Continuous Systems:** Wave equation, transverse vibration of strings, longitudinal vibration of bars, Torsional vibrations of a uniform shaft and transverse vibration of beams. **08 Hrs**

Text Books

1. G.K. Grover, *"Mechanical Vibrations"*, Nem Chand and Bros, Roorkee, 2009.
2. Singiresu S. Rao, *"Mechanical Vibrations"*, Pearson India Education Services P. Ltd., Noida, 2016.
3. V.P. Singh, *"Mechanical Vibrations"*, Dhanpat Rai & Co. (Pvt.) Ltd., New Delhi, 2016.
4. Debabrata Nag, *"Mechanical Vibrations"*, Wiley India Pvt. Ltd. New Delhi , 2013.
5. Kelly S. Graham, *"Mechanical Vibrations"*, McGraw Hill Education (India) Pvt. Ltd., New Delhi , 2007.

Subject Code: LPCME-112 Subject Name: Refrigeration and Air Conditioning Laboratory

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 6	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 02 Hrs
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Nil

On Completion of the course, the student shall be able to:

CO#	Course Outcomes(CO)
1	Understand and evaluate the performance of different types of refrigeration systems.
2	Estimate cooling and heating load of desired space for different refrigeration and air conditioning applications.
3	Understand the working of various commercial and industrial RAC systems.
4	Evaluate the performance of an air conditioning system.
5	Understand the importance of Psychrometric properties of moist air for an air conditioning system.
6	Recognize and select the different parts/components required for RAC systems.

S. No.	Name of Practical
1	Study of various elements of a vapour compression refrigeration system through cut sections models / actual apparatus.
2	Study and performance testing of domestic refrigerator.
3	Study the performance testing of Electrolux refrigerator.
4	Study and performance testing of an Ice plant.
5	Calculation/ Estimation of cooling load for a large building.
6	Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning.
7	Visit to a cold storage for study of its working.
8	Study and performance testing of window type room air conditioner.
9	Study and performance testing of water cooler.

Reference Material

Manuals available in Lab.

Subject Code: LPCME-111 **Subject Name: Mechanical Vibrations Laboratory**

Programme: B.Tech. (ME)	**L:** 0 **T:** 0 **P:** 2
Semester: 6	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:**100%
External Marks: 20	**Duration of End Semester Exam(ESE):** 02 Hrs
Total Marks: 50	**Course Status:** Compulsory

Prerequisites: Nil

On Completion of the course, the student shall be able to:

CO#	Course Outcomes(CO)
1	Determine the viscosity of fluid.
2	Determine radius of gyration of compound pendulum.
3	Determine natural frequency of simple structure.
4	Determine modulus of elasticity of given sample wire.
5	Demonstrate forced vibration.
6	Determine coefficient of dry friction.

S. No.	Name of Practical
1	To determine the viscosity of given fluid by single wire torsional pendulum.
2	To determine the modulus of elasticity from free vibration test.
3	To determine coefficient of dry friction from measurement of natural frequency of vibration of a bar resting on two disks rotating in opposite direction.
4	To determine radius of gyration of a given compound pendulum.
5	To determine the natural frequency of vibration of free vibrations of two rotor system theoretically and experimentally.
6	To verify the Dunkerley's rule. $1/f^2 = 1/f_L^2+1/f_B^2$.
7	To determine the frequency and time period of oscillation of longitudinal vibration of helical spring actually by experiment and theoretically.
8	To determine the frequency and time period of oscillation of Torsional Vibration of undamped single rotor shaft system.
9	To determine the frequency and time period of oscillation of the undamped free vibration of equivalent Spring Mass System.
10	To determine the frequency and time period of oscillation of forced vibration of equivalent Spring Mass System.
11	To determine the effect of different damping on the forced vibration of the beam.

Reference Material

Manuals available in Lab.

Subject Code: PEME-103 S**ubject Name: Non-Conventional Energy Resources**

Programme: B.Tech.(ME**)**	**L:** 4 **T:** 0 **P:** 0
Semester: 6^{th} /7^{th} /8^{th}	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites:

Additional Material Allowed in ESE: Design Data Book [Scientific Calculator]

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Know various types of energy resources
2	Design various types of solar collectors and use solar energy applications for different systems
3	Understand principles of wind energy generation and estimate the power output
4	Know various types of direct energy conversion systems
5	Know types of biogas generators and their functioning
6	Understand applications of Geothermal , Tidal and wave energy

Detailed Contents:

Part-A

1. **Introduction**: Renewable and non-renewable energy sources; their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements. 0**4 Hrs**
2. **Solar Energy**: Solar radiation - beam and diffuse radiation; earth sun angles; attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles; general description and design procedures of flat Plate and concentrating collectors; Solar energy storage systems - their types; characteristics and capacity; solar ponds. Applications of solar energy in water; space and process heating; solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar photovoltaic system; economic analysis of solar systems. **10 Hrs**
3. **Wind Energy**: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components; various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations. **10 Hrs**

Part-B

4. **Direct Energy Conversion Systems**:
   i. Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle; types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields.
   ii. Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration.

iii. Thermionic generators: thermo- ionic emission and materials; working principle of thermionic convertors.
iv. Fuel Cells: thermodynamic aspects; types; components and working of fuel cells.
v. Performance; applications and economic aspects of above mentioned direct energy conversions systems. **12 Hrs**

5. **Miscellaneous Non-Conventional Energy Systems**:

i. Bio-mass: Concept of bio-mass conversion; photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants
ii. Geothermal: Sources of geothermal energy - types; constructional features and associated prime movers.
iii. Tidal and wave energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices
Advantages/disadvantages and applications of above mentioned energy systems. **12 Hrs**

Text Books

1. H. P. Garg and Jai Prakash, "*Solar Energy: Fundamentals and Applications"*, Tata McGraw - Hill, 2000.
2. S. P. Sukhatme, "*Solar Energy: Principles of Thermal Collection and Storage"*, Tata McGraw Hill, Third Edition 2008.
3. John A. Duffic and W. A. Beckman, "*Solar Engineering of Thermal Processes"*, John Wiley, Fourth Edition 2013.
4. Chang and S. L. Sheldon, "*Energy Conversion"*, Prentice Hall, 1963, Reprinted in 2015.
5. J. O M. Bockris and S. Srinivasan, "*Fuel Cells: Their Electrochemistry"*, McGraw Hill, 1969.

Subject Code: PEME-104 **Subject Name: Energy Conservation and Management**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Apply the basic knowledge of different engineering concepts and principles for energy conservation and management of system.
2	Evaluate the energy saving & conservation in different electrical and thermal utilities.
3	Understand efficient steam, thermal & electric power utilization, saving and energy recovery in these systems.
4	Prepare energy audit report for different energy conservation instances.
5	Understand Importance and role of Energy Manager/ Energy Auditor
6	Comprehend current global energy scenarios, various energy protocols and energy crisis.

Detailed Contents:

PART -A

1. **Energy Scenario**: Global energy requirements; Classification of Energy; Indian energy scenario; Depletion of conventional energy resources such as coal, gas, oil, nuclear fuel; Sectorial energy consumption (domestic, industrial and other sectors); energy needs of growing economy; conventional energy resources; need for energy conservation, its potentials and incentives. Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE). **04 Hrs**
2. **Energy management and energy audit**: Energy management, Need for energy efficient devices, energy efficient motors, design features of energy efficient motors, energy efficient lighting system, barriers to energy efficient devices; categories of energy audit, Energy audit methodology, format of the energy audit report, case studies of energy audits. **08 Hrs**
3. **Energy Storage System:** Overview of energy technologies, applications of energy storage, Direct Electric Storage, Electro Chemical Energy Storage, Mechanical Energy Storage, Direct Thermal Storage, Thermo Chemical Energy Storage. **10 Hrs**

PART - B

4. **Energy Efficiency in Thermal Utilities and systems**:
   Boilers: Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, super critical boilers, Plant woodhouse keeping measure in boilers.
   Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam condensate and flash steam recovery system, identifying opportunities for energy savings.
   Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

Insulation and Refractories: Insulation-types and application, Refractory-types, selection and application of refractories, heat loss.

Heat Exchangers: recuperates economizers waste heat boilers, heat pipe heat exchangers regenerators

Heating, ventilation, air conditioning (HVAC) and Refrigeration System: Factors affecting Refrigeration and Air conditioning system performance and savings Opportunities, Plant woodhouse keeping measure in Air Conditioning system. **10 Hrs**

5. **Energy Conservation of real Industry systems**: energy conservation and their energy usage pattern in energy intensive industry i.e. iron and steel industry, pulp and paper industry, textile industry. **08 Hrs**
6. **Energy and environment, air pollution, climate change**: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF). **08 Hrs**

Text Books

1. D.A. Reay, *"Industrial Energy Conservation Handbook"* , Oxford Press., 2nd edition 2016
2. P. L. Diwakar Rao*, "Energy Conservation Handbook",* Utility Publication Ltd., 1988
3. A. Chakrabarti*, "Energy Engineering and Management",* PHI Learning Ltd., 2011
4. F. Kreith, *" Energy Management and Energy Conservation Handbook"* CRC press
5. D. R. Patrick, S.W. Fardo , *"Energy Conservation Guidebook",* 2nd Edition, CRC Press .

Reference Books:

1. *"Energy Management and Conservation Handbook"*, CRC Press, 2016.
2. S.S. Thipse, *"Energy Conservation and Management"*, Alpha Science International Ltd, 2014.
3. Wayne C. Turner, Steve Doty, *"Energy Management Handbook: 8th Edition Volume II"*, Lulu Press Inc, 2013.
4. Barney L. Capehart, Wayne C. Turner, William J. Kennedy,*"Guide to Energy Management"*, Fairmont Press, 2008.

Subject Code: PEME-110 **Subject Name: Automobile Engineering**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Identify the different parts of the automobile and to know the terminology related to automobiles.
2	Understand various types of frames, chassis, power units, suspension systems and wheel tyre constructional details and their applications
3	Analyse the environmental implications of automobile emissions and their mitigation
4	Understand the working and application of fuel supply system and various characteristics of fuels.
5	Understand the working of various lubrication and cooling systems and rating/characteristics of lubricants and coolants
6	Understand the automated/manual transmissions, steering system with geometry, braking system, electronic and electric systems with complete vehicle maintenance.

Detailed Contents:

PART -A

1. **Structure and Power System**: Basic structure and terminology, general layout and type of automotive vehicles (i.e. e-vehicles, farm and constructional vehicles, Frameless and unitary construction); position of power unit, Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system, silencers, types of pistons and rings. Loads on the frame, considerations of strength and stiffness, engine mounting, independent suspension systems (Mac Pherson, Trailing Links, Wishbone), shock absorbers and stabilizers; wheels and tyres, tyre wear, constructional details of plies. **12 Hrs**
2. **Air, Fuel and Exhaust System:** Air cleaner and fuel pumps; Air fuel requirements and carburetion; constructional details of Carter carburetors and fuel injection systems; MPFi (Petrol), Diesel fuel system, inline injection pump, injector and nozzles, Common Rail fuel supply system. Alternate fuel systems for CNG, LPG and LNG. **08 Hrs**
3. **Lubrication and Cooling System**s: Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water cooling systems; radiator, thermostat, intercooler, pump and fan, vehicle cabin cooling and heating systems. **07 Hrs**

PART - B

4. **Transmission, Steering and Braking system**: Basic requirements and standard transmission systems; Automated Manual Transmission (AMT), CVT, constructional features of automobile clutch, gear box, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission, Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering, Ball re-circulating mechanism, General braking requirements; Mechanical, hydraulic, vacuum power and servo brakes, parking brake system; Weight transfer during braking and stopping distances. **10 Hrs**
5. **Electric and Electronic Systems:** Classification, Introduction to Conventional and microprocessor based ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation, vehicle dashboard components, cruise control system and sensors: RPM sensor, coolant and fuel sensor, speed sensor, GPS, fire sensor. **07 Hrs**
6. **Maintenance**: Preventive maintenance, trouble shooting and rectification in different systems; engine tuning and servicing, major tools used for maintenance of automobiles. **04 Hrs**

Text Books

1. W.H Crouse and Donald Anglin *"Automotive mechanics",* McGraw Hill, 10th Edition, 2006.
2. J. Heitner*, "Automotive Mechanics",* East West Press, 2016
3. Kirpal Singh, *"Automobile Engineering Vol. I and II",* Standard Publishers, 2014
4. J. Webster, *"Auto Mechanics",* Glencoe Publishing Co. 3rd Edition,1986
5. P.S Gill, *"Automobile Engineering",* S.K Kataria 3rd Edition, 2013.

Reference Books:

1. Tom Denton, *"Automobile Mechanical and Electrical Systems"* , CRC Press , 2017.
2. Sudhir Kumar Saxena, *"Automobile Engineering"* , University Science Press, 2009.
3. Ttti, *"Automobile Engineering"*, Tata McGraw-Hill, 2002.

Subject Code: PEME-202 **Subject Name: Product Design and Development**

Programme: B.Tech. (ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 20**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Analyze, evaluate and apply the methodologies for product design, development and management.
2	Understand the technical and business aspects of the product development process.
3	Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
4	Use basic fabrication methods to build prototype models for hard-goods and soft-goods and packaging.
5	Skilled in implementation of gathering data from customers and establish technical specification .
6	Apply technique of PDD Manufacturing.

Detailed Contents:

PART – A

1. **Introduction**: Introduction to product design. Classification/ Specifications of Products. Principal requirements of good product design. Importance of product design in industry. Essential factors and considerations affecting product design. Product design methodology and techniques. **06 Hrs**
2. **Visual Design**: Basic elements and concepts of visual design. Materials, forms, function and color relationships. Color theory. Product graphics and different methods of product graphics. Visual communication. **06 Hrs**
3. **Ergonomics**: Human engineering considerations in product design. Human factors in design principles of user-friendly designs. Introduction of ergonomics, man/ machine/environment systems concept. Development of ergonomics. Psychological & physiological considerations. **06 Hrs**
4. **Controls and Displays**: Hand controls and foot controls, location of controls and work place envelope. Recommendation about hand and foot push buttons, rotary selector switches, hand wheels, crank levers etc. Instruments and displays. **06Hrs**

PART – B

5. **Material Packaging**: Packaging and function of a package. Packaging materials their characteristics and applications. Packaging design considerations. Modern packaging processes. **04 Hrs**
6. **Value Engineering**: Value engineering, concept, advantage and applications. Value. Types of values. Analysis of function, using and evaluating functions. Value engineering techniques. Value control. **04 Hrs**
7. **Product Development**: Defining new Product and their classification. Product life cycle. New product development process. Product development and testing. **04 Hrs**

Text Books:

1. A. K. Chitale, R. C. Gupta, "*Product Design and Manufacturing"*, PHI Learning, 2013.
2. Karl T. Ulrich. *"Product Design and Development"*, McGraw-Hill Education, 2003
3. B. W. Niebel and A. B. Draper , *"Product design and process engineering"*, McGraw-Hill, New York, 1974.
4. Arthur E. Mudge , *"Value engineering: a systematic approach"*, McGraw-Hill, New York, 1971.
5. W. H. Mayall, *"Industrial design for engineers"*, London : Illife Books, 1967.

Reference books:

1. Kjell b. Zandin, *" Hand Book of Maynard's Industrial Engineering"*, McGraw-Hill, 2001.
2. Ali Jamnia, *"Introduction to Product Design and Development for Engineers"*, CRC Press, 2018.
3. Fu Xiao Chen, Ye Han, Hui Xuan Zhang, *"Product Design and Manufacture"* , Trans Tech Publications Limited, 2011.
4. Morris Asimov, *"Introduction to Design"*, Prentice-Hall ,1962.

E-Books and online learning material

1. Product design and Development Accessed on Feb, 2021
   https://www.pdfdrive.com/product-design-and-development-e38289913.html
2. Product design and Development Accessed on Feb, 2021
   http://www.mslab.boun.edu.tr/docs/ETM551Lecture05.pdf

Online Courses and Video Lectures

1. https://nptel.ac.in/courses/112/107/112107217/ Accessed on Feb, 2021
2. https://www.youtube.com/watch?v=HN9GtL21rb4&list=PLSGws_74K018yZOnbSaqWJZ837QyBB7vu Accessed on Feb, 2021

Subject Code: PEME-209 **Subject Name: Mechatronics**

Programme: B.Tech.	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Compulsory

Prerequisites: NA.

Additional Material Allowed in ESE: [Scientific Calculator]

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1	Understand key elements of mechatronics system.
2	Understand the functions and types of sensors and transducers.
3	Design the pneumatic and hydraulic circuits for industrial applications.
4	Understand the architecture and operation of typical microprocessors and microcontrollers.
5	Apply the concept of electrical ladder logic and its relationship to programmed PLC instruction.
6	Apply the Applications of mechatronics for real world.

Detailed Contents:

Part-A

1. **Introduction:** Concept of mechatronics system, Components of mechatronics system, Need and role of mechatronics in design; manufacturing and industrial automation. **04Hrs**
2. **Sensors and Transducers:** Sensors and transducers; Performance terminology; Displacement, position and proximity, Velocity and motion, Force, Fluid pressure, Liquid flow, Liquid level, Temperature, Light sensors; Selection of sensors. **10Hrs**
3. **Pneumatic and Hydraulic Actuation Systems:** Actuation systems- Pneumatic and Hydraulic systems; Direction control valves, Pressure control valves; Cylinders, Servo control valves, Rotary actuators; Design of simple pneumatic and hydraulic circuits. **14Hrs**

Part-B

4. **Microprocessors:** Computer and Interfacing; AD and DA converters; Microcomputer structure, Microcontrollers, Application of Microcontrollers. **08Hrs**
5. **Programmable Logic Controllers:** Programmable logic controller, Basic PLC structure, Input/output processing, Ladder programming, Instruction Lists, Latching and internal relays, Sequencing, Timers and counters. **06Hrs**
6. **Design for Mechatronic system:** Introduction, Stages in designing mechatronics systems, Case studies of mechatronic systems. **06Hrs**

Text Books:

1. W. Bolton, *"Mechatronics"*, Pearson Education, 2011.
2. David G Alciatore, Michael B Histand, *"Introduction to Mechatronics and Measurement Systems"*, Tata McGraw Hill, 2006.
3. S.R. Majumdar, *"Pneumatic Control"*, Tata McGraw Hill, 2004.

4. Musa Jouaneh, *" Fundamentals of Mechatronics"*, Cengage Learning, 2012.
5. Devdas Shetty, Richard A. Kolk, *"Mechatronics System Design"*, Cengage Learning, 2011.

Reference Books:

1. D.M. Auslander, C.J. Kempf, *"Mechatronics: Mechanical System Interfacing"*, Prentice Hall Inc., 1996.
2. Brian Morriss, *"Automated Manufacturing Systems – Actuators, Controls, Sensors and Robotics"*, McGraw Hill, 2000.
3. M.P. Groover, *"Automation, Production Systems and Computer Integrated Manufacturing"*, Pearson Education, 2009.

Subject Code: PEME-213 **Subject Name: Computer Aided Design**

Programme: B.Tech(ME)	**L**: 3 **T**:0 **P**: 0
Semester: 6th/ 7th/8th	**Teaching Hours**: 48
Theory/Practical: Theory	**Credits**: 4
Internal marks: 40	**Percentage of Numerical/Design/Programming Problems**: 10%
External marks: 60	**Duration of End Semester Exam**: 03 Hrs
Total Marks: 100	**Course Status**: Elective

Prerequisites: NA

Additional Material Allowed in ESE: NIL

On Completion of this course, students will have the ability to:

CO#	Course Outcomes
1	Describe the role of computer systems in design and manufacturing.
2	Understand geometric models, geometric modeling and apply various techniques.
3	Conceptualize the integration of Computer Aided Design and business aspects in an industry.
4	Analyse various curves and surfaces.
5	Evaluate component for kinematic analysis.
6	Understand different graphic packages.

Detailed Contents:

Part- A

1. **Introduction to CAD**: Introduction to CAD and its role in Product design and development cycle; CAD system and its evaluation criteria ; advanced input and output devices, Display devices; Functions of a graphics package and Graphics standard GKS; IGES and STEP; Application areas of CAD. **10 Hrs**
2. **Geometric Modeling**: Need and types of Geometric Modeling: Wireframe; surface and solid modeling; Geometric Modeling Techniques: Boundary Representation (B-rep); Constructive Solid Geometry (CSG); Parametric Modeling Technique; Mass; volumetric properties calculations; concepts of hidden-line removal and shading; Mechanical Assembly Kinematics analysis and simulation. **14 Hrs**

Part- B

3. **Geometric Transformations:** Overview of Mathematics preliminaries; matrix representation of 2 and 3 dimensional transformation for translation; scaling; rotation about principal axes; mirror imaging about a plane; principal axes and origin; Concatenation of transformation matrices. Applications of geometric transformations. **12 Hrs**
4. **Representation of curves and surfaces:** Non-parametric and parametric representation of curves; parametric representation of Hermite Cubic; Bezier curves; Uniform and Non uniform B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces(Bilinear Surface; Coons Surface Patch; Bi-cubic Surface Patch; Bezier Surface; B spline surface). **12 Hrs**

Text Books:

1. Mikell P. Groover, Emory W. Zimmer's, *"CAD/CAM: Computer-Aided Design and Manufacturing",* PHI, 1984.

2. D. D. Bedworth, M. R Henderson & P.M. Wolfe, *"Computer Integrated Design and Manufacturing"*, Tata McGraw Hill, 1991.
3. Z. Ibraham*, "CAD/CAM - Theory and Practice",* Tata McGraw Hill, 2009.
4. P. N Rao, *"CAD/CAM Principles and Applications",* Tata McGraw Hill, 2004.
5. Jayanta Sarkar, "Computer Aided Design: A Conceptual Approach" , CRC Press , 2014.

Reference Books

1. Srinivasa Prakash Regalla, *"Computer Aided Analysis and Design"*, I K International Publishing House, 2010.
2. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, *"Computer Aided Design and Manufacturing"*, PHI Learning, 2008.
3. Zhuming Bi, Xiaoqin Wang, *"Computer Aided Design and Manufacturing"* , Wiley, 2020.

Subject Code: PEME-204 **Subject Name: Tool and Cutter Design**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Demonstrate the principle elements of cutting tools and tool geometry.
2	Evaluate the design elements and geometrical parameters of the tool life.
3	Develop in-depth knowledge of Twist drill geometry, construction and design.
4	Do analysis of correct profile of Form tools.
5	Explain the problems related to measurement of Milling and Broaching.
6	Explain the problems related to measurement of Reamers.

Detailed Contents:

PART -A

1. **Introduction:** Ferrous tool materials, Desirable properties of cutting tool materials, Relative properties of the various tool materials and their uses. Fundamentals of cutting tool design. Principles elements of cutting tools and tool geometry. **07 Hrs**
2. **Design of Single Point Tools:** Design Elements and Geometrical parameters of the tool point. Design for H.S.S Tools. Construction and design of carbide and ceramic tipped tools, Chip breaker purpose construction and design, Design of high production Tools, Principles types and their design. **09 Hrs**
3. **Design of Drills:** Purpose and principal types of drills, twist drill geometry, construction and design, Drill point geometry.

PART-B

4. **Design of Form Tools**: Various types of form tools, radial feed and tangential type form tool construction and design. **06 Hrs**
5. **Design of Milling Cutters**: Purpose, types and geometry of milling cutters, Design of profile sharpened plain milling cutter, face milling cutter, side milling cutter. Selection of cutter geometry. **08 Hrs**
6. **Design of Broaches and Reamers**: Purpose and types of broaches, Design and construction of internal broaches and external surface broaches. Reamers: Nomenclature and classification, construction and geometry of reamers. **06 Hrs**
7. **Tool Design for N.C. Machine Tools:** Introduction, Cutting tools for NC, Tooling methods, Automatic tool changers. **06 Hrs**

Text Books

1. Cyril Donaldson, George H. LeCain, V. C. Goold, *"Tool Design",* Tata McGraw Hill, 2017
2. Arshinov & Others, *"Metal Cutting Principles and cutting Tool Design and Production"*,Mir Publications.
3. Helmi A. Youssef, Hassan El-Hofy, *" Machining Technology"* ,Taylor and Francis Group.

4. David Alkire Smith, David Spitler, Jeff Lantrip, John G. Nee , *"Fundamentals of Tool Design"*, Society of Manufacturing Engineers, 2003.
5. B. J. Ranganath, *"Metal Cutting and Tool Design"*, Vikas Publishing House Pvt Limited , 1999.

Subject Code: PEME-301 **Subject Name: Non-Traditional Machining**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 20**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the concept of latest technologies and need of Non-Traditional Machining processes in manufacturing.
2	Understand the principle, mechanism of metal removal of various non-conventional machining processes.
3	Analyze the various process parameters and their effect on the component machined on various unconventional machining processes.
4	Evaluate advantages, applications and limitations of the various non-traditional machining processes under different working conditions.
5	Understand the applications of different processes.
6	Select suitable process for stringent requirement of manufacturing industry

Detailed Contents:

Part - A

1. **Introduction to Non-traditional machining**: Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes. **04 Hrs**
2. **Advanced Mechanical Processes**: Ultrasonic machining; Water Jet Machining and Abrasive Flow Machining-elements of process; Applications and limitations. **08 Hrs**
3. **Electrochemical & Chemical Removal Processes:** Principle of operation; elements and applications of Electrochemical Machining; Electro-chemical grinding; Electro-chemical deburring; Electro-chemical honing; Chemical machining; Photo-chemical machining. **08 Hrs**

Part - B

4. **Thermal Metal Removal Processes:** Electric Discharge Machining- Mechanism of metal removal; electrode feed control; die electric fluids flushing; selection of electrode material; applications. Plasma Arc Machining- Mechanism of metal removal; PAM parameters; Equipment's for unit; safety precautions and applications. Laser Beam machining- Material removal; limitations and advantages. Electron-Beam Machining-; Generation and control of electron beam; process capabilities and limitations. **12 Hrs**

5. **Hybrid Machining Processes:** Hot machining, High velocity forming of metals, explosive forming: principle and applications. **08 Hrs**

Text Books:

1. P. C. Panday and H. S. Shan ,*"Modern Machining Processes"*, Tata McGraw Hill , 2008.
2. G. Boothroyd and W.A. Knight, *"Fundamentals of Machining and Machine Tools"*, Taylor and Francis, 2006.
3. G.F. Benedict, *"Non-traditional Manufacturing Processes"*, Marcel Dekker Inc., 1987.
4. V.K. Jain, *"Advanced Machining Processes"*, Allied Publishers, 2007.
5. Abdel Hassan, El-Hofy Gawad , *"Fundamentals of Machining Processes: Conventional and Nonconventional Processes"*, Taylor& Francis, 2014.

Reference Books:

1. J. Weller, *"Nontraditional Machining Processes"*, Society of Manufacturing Engineers, Publications.
2. Carl Sommer, *" Non-Traditional Machining Handbook"*, Advance Publishing, Incorporated.
3. HMT, "*Production technology*" , McGraw Hill Education India Pvt. Ltd. 2001

E-Books and online learning material

1. Nontraditional Machining Processes Accessed on Feb, 2021
   https://www.me.iitb.ac.in/~ramesh/courses/ME338/non_trad.pdf
2. Nontraditional Machining Processes Accessed on Feb, 2021
   http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf

Online Courses and Video Lectures

1. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-35.pdf Accessed on Feb, 2021
2. https://www.youtube.com/watch?v=PaYInS9axxw Accessed on Feb, 2021

Subject Code: PEME-303 **Subject Name: Computer Integrated Manufacturing**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/ 8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the working of different computer graphics systems.
2	Apply Group technology and flexible manufacturing systems knowledge on various processes.
3	Use the computer in various stages of manufacturing: production, planning.
4	Apply the computer aided quality control on various processes.
5	Understand the working of the various production support machines and systems.
6	Understand the methodology of communication and planning in CIM.

Detailed Contents:

Part -A

1. **Introduction:** Scope, islands of automation, architecture of CIM, information flow in CIM, elements of CIM, benefits, limitations, obstacles in implementation. **03 Hrs**
2. **CAD/CAM/CAE:** Product Design and CAD, application of computers in design, CAM - manufacturing planning and control, scope of CAD / CAM and CIM, concurrent engineering, design for manufacturing and assembly. **04 Hrs**
3. **Group Technology:** Concept, design and manufacturing attributes, part families, composite part, methods of grouping, PFA, classification and coding system- OPITZ, Relevance of GT in CIM, GT and CAD, benefits and limitations of GT. **05 Hrs**
4. **Flexible Manufacturing Systems:** Concept, flexible & rigid manufacturing manufacturing cell and FMS structure, types, components of FMS, Distributed Numerical Control (DNC), Building Blocks of FMS, Flexible Assembly System. **05 Hrs**
5. **Computer Aided Production Planning** : need, retrieval and generative type CAPP, role of CAPP in CIM, Computer integrated production management system, aggregate planning, master production schedule, shop floor control, materials requirement planning, capacity planning, manufacturing resource planning and enterprise resource planning. **07 Hrs**

Part - B

6. **Computer Aided Quality Control:** Objectives, non contact inspection methods, equipment; contact type inspection: Co-ordinate Measuring Machines (CMM), construction, working principle and applications, Inspection robots. **04 Hrs**

7. **Production Support Machines and Systems in CIM:** Industrial robots for load/unload, automated material handling, automatic guided vehicles, automated storage and retrieval system. **06 Hrs**
8. **Data Acquisition and Database Management Systems:** (a) Data acquisition system,type of data, automatic data identification methods, bar code technology, machine vision.(b) Data and database management system, database design requirements, types of DBMS models-hierarchical, network and relational models and their applications. **06 Hrs**
9. **Communication in CIMS:** Role of communication in CIMS, requirements of shop floor communication, types and components of communication systems in CIM. **03 Hrs**
10. **Planning and Implementation of CIMS**: Planning for CIMS, need for planning, Phases of CIM implementation, incremental implementation and one time implementation, CIM bench marking, Economic and social justification of CIM. **05 Hrs**

Text Books

1. Nanua Singh, "*Systems Approach to Computer Integrated Design and Manufacturing*", John Wiley Sons, 2009.
2. M.P. Groover, "*Automation Production Systems and CIM*", Prentice Hall, 2008.
3. Andrew Kusiak, "*Intelligent Manufacturing System*", Prentice Hall Inc., New Jersey, 1992.
4. P. N. Rao, "*CAD/CAM: Principles and Applications*", Tata McGraw Hill, 2010.
5. S. Kant Vajpayee. , "*Principles of Computer Integrated Manufacturing*", Prentice Hall of India, 2003.

Reference Books

1. Chris McMahon and Jimmie Browne, "*CAD CAM Principles, Practice and Manufacturing Management*", Pearson Education 2nd edition, 2005.
2. Viswanadham, N. & Narahari," Performance Modeling of Automated Manufacturing Systems ", Prentice Hall of India, 2 nd edition,2015
3. James A. Rehg, H. W. Kraebber, "Computer Integrated Manufacturing" ,Pearson Education, 2nd edition,2005.

E-Books and online learning material

1. Computer Integrated Manufacturing System Accessed on Feb, 2021
   http://www.alphace.ac.in/downloads/notes/me/10me61.pdf
2. Computer Integrated Manufacturing by Roger Hannam Accessed on Feb, 2021
   https://www.academia.edu/9277069/computer_integrated_manufacturing_roger_modfied

Online Courses and Video Lectures

1. https://nptel.ac.in/courses/112/104/112104289/ Accessed on Feb, 2021
2. https://opencourses.emu.edu.tr/course/view.php?id=75 Accessed on Feb, 2021

Subject Code: PEME-312 **Subject Name: Non-Destructive Testing**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/ 8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 20**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand and recognize various Non-Destructive Testing Methods (NDT) used for testing of engineering products.
2	Use NDT methods for detecting the flaws in specimen.
3	Suggest suitable NDT techniques for engineering products.
4	Understand the role and benefit of NDT for improving the quality of product.
5	Magnetic analysis of steel bars and tubing.
6	Measurement of thickness by ultrasonic method.

Detailed Contents:

Part - A

1. **Introduction**: Classification of techniques of material testing; Need and Significance of Non Destructive Testing methods; type of Non Destructive testing methods. **04 Hrs**
2. **Radiographic Examination**: Radiant energy and radiography; practical applications; X-ray and Gamma –ray equipment; effect of variables on radiographs; requirement of a good radiograph; interpretation of radiograph; safety precautions; Xero -radiography. **10 Hrs**
3. **Magnaflux Methods**: Basic principles; scope and applications; magnetic analysis of steel bars and tubing magnetization methods; equipment; inspection medium; preparation of surfaces Fluorescent Penetration inspection; Demagnetization. **12 Hrs**

Part - B

4. **Electrical and Ultrasonic Methods**: Basic principles; flaw detection in rails and tubes (Sperry Detector); Ultrasonic testing surface roughness; moisture in wood; Detection of defects in ferrous and non-ferrous metals; plastics; ceramics; measurement of thickness; hardness; stiffness; sonic material analyzer; proof tests; concrete test hammer. **08 Hrs**
5. **Photo-elasticity**: Concept and applications of Plane and circular polarization; Photo stress; models. **06 Hrs**

Text Books:

1. Davies H.E., Troxell G. E. and Hauck G. F. W., *"The Testing of Engg. Materials"*, McGraw Hill, 1982.
2. Armstrong W. H., *"Mechanical Inspection"*, Literary Licensing, 1st Edition Reprint, 2012.
3. Baldev Raj, *"Practical Non – Destructive Testing"*, Narosa Publishing House, 1997.

4. J Prasad and C. G. Krishnadas Nair , *"Non-Destructive Test and Evaluation of Materials"* , McGraw Hill Education , 2011.
5. Ravi Prakash, *" Non-destructive Testing Techniques"* , New Academic Science Ltd, 2009

Reference Books:

1. Cartz Louis , *"Nondestructive Testing"*, ASM International, Materials Park, Ohio, 1995.
2. Matthew Golis, *"An Introduction to Nondestructive Testing"*, American Society of Nondestructive Testing, 1991.
3. P.J. Shull, *"Nondestructive Evaluation – Theory, Applications, and Applications"*, Marcel Dekker, 2002.

Subject Code: PEME-313 **Subject Name: Heat Treatment Processes**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th/ 7th/ 8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 20**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Course Status:** Elective

Prerequisites: NIL.

Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Knowledge of Physical Metallurgy for the understanding theory of Heat Treatment.
2	Understanding Principles and Processes of Heat Treatment.
3	Grasping concepts of Hardenability and significance of suitable quenching media.
4	Comprehending Surface hardening and Thermo Chemical Heat Treatment Processes.
5	Understanding heat treatment Processes of Commercial steel, Cast Iron & Non-ferrous metals.
6	Insight into procedures for testing Heat treated components and energy economy in heat treatment processes.

Detailed Contents:

Part - A

1. **Nature of Metals, Alloys & Iron –Iron carbide equilibrium diagram:** Nature of Alloys, Phase diagrams, Iron-Cementite Phase diagram, Effect of Alloying elements on Iron –Iron carbide phase diagram, Classifications of steel. **06 Hrs**
2. **Principles of Heat Treatment of Steels**: Introduction & importance of Heat Treatment, Definition of various Phases and terms used in Heat Treatment, Kinetics of formation of Austenite, Austenite grain size, Determination and importance of Austenite grain size, Decomposition of Austenite, Time Temperature Transformation Curves, Effect of alloying elements on TTT curves, Continuous Cooling Transformation, Pearlitic transformation,: Mechanism, Kinetics, Effect of alloying elements on transformation, Inter-lamellar spacing, Bainitic transformation: Mechanism, Characteristics, Bainitic structure. Martensitic transformation: Mechanism, Kinetics, Ms - Mf temperatures, A thermal & isothermal martensite, Effect of applied stress on transformation, Habit planes, Bain distortion model, Retained austenite. **09 Hrs**
3. **Heat treatment processes:** Stress Relieving, Annealing, Spheroidizing, Normalizing, Hardening and Tempering, Hardening of typical steels, cast irons and non-ferrous alloys. **05 Hrs**
4. **Hardenability and Quenchants**: Significance, Measurement Grossman method, Critical and ideal critical diameter, Jominy End Quench method, Use/Significance of Hardenability data, Effect of grain size and composition, Residual stresses, Factors affecting hardenability, Quenchants: Characteristics of quenchants, Different quenching media, Synthetic quenchants, Mechanism of quenching. **04 Hrs**

Part - B

5. **Surface hardening of metals:** Principles involved in induction and flame hardening methods and application of selective hardening, Laser hardening, Case carburizing (solid, liquid and gaseous), Cyaniding, Carbonitriding, Nitriding, Depth of penetration - its measurement and

relation with time and temperature. Special heat treatment processes: Austempering, Martempering, Ausforming, Patenting and Cryogenic treatment. Thermo-Mechanical treatments. **06 Hrs**

6. **Heat treatment of alloy Steels and Non-Ferrous alloys:** Heat Treatment of Tool and dies steels, Stainless steels and cast irons – specific examples, Heat treatment of Aluminium alloys, titanium alloys and copper alloys, Concept of age-hardening. **04 Hrs**
7. **Design for heat treatment**: Recommended features of parts suitable for heat treatment, Heat treatment furnaces- their temperature and atmosphere control, Defects in heat treated parts their Causes and remedies. Heat treated material testing and Energy economy in Heat treatment. **06 Hrs**

Text Books:

1. T. V. Rajan, C. P. Sharma and A. Sharma, *"Heat Treatment (Principles and Techniques)"* , PHI , 2011
2. D. S. Clark and W. R. Varney , *"Physical Metallurgy for Engineers"*, East-West Press, 2013
3. S. H. Avner, *"Introduction to Physical Metallurgy"*by, Tata Mc-Graw Hill, 1997.
4. Yu. M. Lakhtin , *"Engineering Physical Metallurgy and Heat Treatment"* by, MIR Publishers, 1980.
5. V D Kodgire and S V Kodgire, *"Material Science and Metallurgy for Engineers"* by Everest Publishing House , 2011.

Reference Books:

1. ASM, *"Metals Hand Book: Heat Treating"*, Metals Parks, Ohio, 2013
2. Vijendra Singh, *"Heat Treatment of Metals"*, Standard Publishers Distributors,2020.
3. George Krauss: *"Steels-Heat Treatment and Processing Principles"*, ASM International, Materials Park, Ohio, 1990.
4. A.G. Guy, *"Elements of Physical Metallurgy"*, Addison Wesly, 1974.

Subject Code: OEME-106 **Subject Name: Industrial Engineering**

Programme: B.Tech. (ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 40
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming – 0%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Open Elective

Prerequisites: NIL.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Know the functions and required qualities of an Industrial Engineer.
2	Apply work sampling and time study techniques for productivity improvement.
3	Identify and analyze the effect of working environment on worker's health.
4	Learn about relevant management concepts.
5	Decide and Manage the plant location and layout effectively.
6	Use modern techniques of industrial engineering for betterment of industry

Detailed Contents:

Part -A

1. **Basics of Industrial Engineering:** Objectives, need and scope of industrial engineering, Functions of industrial engineering department, Qualities of an industrial engineer, Role of an industrial engineer in industry, Relevance of industrial engineering to achieving performance excellence in industry. **04 Hrs**
2. **Plant Location & Layout:** Importance of plant location, Factors affecting the plant location, Comparison of rural and urban sites. Needs for a good plant layout, Different types viz. Product, process and combination layouts, Development of plant layout. **06 Hrs**
3. **Productivity**: Concept of productivity, Difference of production and productivity, Factors affecting the productivity, Reasons for low productivity, Methods to improve productivity, Productivity improvement programs. **04 Hrs**
4. **Work Analysis:** Need and scope of Work Analysis. Method-study: objectives, step-by-step procedure, charts and diagrams for recording data. Principles of motion economy. Work–measurement: Techniques of work measurement such as work-sampling, stopwatch time study. Need for rating operator, methods of rating, allowances and their types, standard time. Use of standard data techniques. **06 Hrs**

Part - B

5. **Ergonomics**: Need and relevance of ergonomics in industry, introduction to anthropometry, considerations in designing man machine systems, effect of environmental considerations like heat light, ventilation, humidity etc. on human performance, Occupational health and Safety Standard (OHSAS). **06 Hrs**
6. **Concepts of Management:** Planning, Organizing, Staffing, Directing and Controlling, Centralization versus decentralization of authority and responsibility, Concept of benchmarking. **04 Hrs**
7. **Total Employees Involvement (TEI):** Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes. **04 Hrs**

8. **Current Trends:** Definitions, Scope and Applications of Agile manufacturing, Six Sigma, Value Engineering, Just-in-time, Total quality management, Enterprise resource planning, , Kaizen, Total Productive Maintenance. failure mode effect analysis. **06 Hrs**

Text Books

1. A.P. Verma, *"Industrial Engineering & Management"*, S. K. Kataria & Sons, 2014.
2. H.S. Shan, *"Work Study and Ergonomics"* Dhanpat Rai & Co. , 2004.
3. A. Shtub & Y. Cohen, *"Introduction to Industrial Engineering"*, CRC Press, Taylor & Francis Group.
4. O.P. Khanna, *" Industrial Engineering and Management"* , Dhanpat Rai & Co.
5. Philip E Hick, *"Industrial Engineering & Management",* Tata McGraw Hill, 1994.

Reference Books:

1. Telsang Martand, *"Industrial Engineering & Production Management"*, S Chand & Co, 2006.
2. ILO, *"Introduction to Work Study"*, Oxford and IBH Publishing, 3rd Edition, 2008.
3. Lee J. Krajewski, *"Operations Management: Processes and Supply Chains"*, Pearson Education, 2016.

Subject Code: OEME-105 **Subject Name: Total Quality Management**

Programme: B.Tech. (ME)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th/ 7th/8th	**Teaching Hours:** 40
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming – 0%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 03 Hrs
Total Marks: 100	**Subject Status:** Open Elective

Prerequisites: NIL.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the meaning of total quality management.
2	Understand the meaning of quality and industrial applications of total quality control.
3	Apply the various quality control tools.
4	Get the knowledge about different quality standards and their applications.
5	Understand the meaning of total quality management.
6	Understand the meaning of quality and industrial applications of total quality control.

Detailed Contents:

Part -A

1. **Quality and Total Quality Management**; Historical development of TQM, Excellence in manufacturing/service, factors of excellence, relevance of TQM.Applications of TQM. **03 Hrs**
2. **Concept and definition of quality**; total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM. SPC and SQC techniques. **04 Hrs**
3. **Just-in-time (JIT):** Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation. DOL system (Direct online system). **04 Hrs**
4. **Customer complaints:** Customer satisfaction, data collection and complaint, corrective and preventive actions. Policy development and implementation; plan formulation and implementation. **06 Hrs**

Part - B

5. **Total Employees Involvement (TEI):** Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes. **04 Hrs**
6. **Problems solving:** Defining problem; Problem identification and solving process; QC tools. Benchmarking concept, process and types of benchmarking. **04 Hrs**
7. **Quality Systems**: Concept of quality system standards: relevance and origin of ISO 9000; Benefits; Elements of ISO 9000 series, TS 16949.ISO-14001, OHSAS (Occupational health and safety standard) **04 Hrs**
8. **Advanced techniques of TQM**: failure mode effect analysis, APQP (Approval plan for quality process), PPAP (Production part approval plan). **04 Hrs**

Text Books

1. Jens J. Dahlgaard, Ghopal K. Khanji, Kai Kristensen , *"Fundamentals of Total Quality Management"*, Taylor & Francis, 2008.

2. P. N. Mukherjee, *"Total Quality Management",* PHI , 2006.
3. S. Rajaram, *"Total Quality Management"*, Dreamtech Press 2008.
4. D. R. Kiran, *"Total Quality Management: Key Concepts and Case Studies"*, Elsevier Science , 2016.
5. Poorinma M. Charantimath, *"Total Quality Management"*, Pearson Education, 2011

Reference Books:

1. Peratec Ltd , *"Total Quality Management;The Key to Business Improvement"* Springer , 1994.
2. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield, Mary Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, *"Total Quality Management"*, Pearson, 2018.
3. Edward Sallis, *"Total Quality Management in Education"*, Taylor Francis, 2014

Subject Code: PEME-101 Subject Name: I. C. Engines

Programme: B.Tech(ME).	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 40-50
External Marks: 60	**Duration of End Semester Exam (ESE):** 03hours
Total Marks: 100	**Course Status:** Elective III

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Understand the concept Heat Engine and various Air-Standard cycles.
2.	Analyze the fuel-air and actual cycles and their response to influencing variables.
3.	Evaluate different types of conventional IC engine fuels, their combustion requirements.
4.	Design of carburetion and fuel injection system for SI and CI engines.
5.	Calculate various combustion stages and design requirements for combustion chambers of SI and CI engines.
6.	Apply their knowledge in measuring various performance parameters of IC engine.

Detailed Contents:

Part-A

1. **Introduction:** Definition of engine: Heat Engine, Classification & Nomenclature, working principle of four/ two stroke spark ignition (SI) and compression ignition (CI) engine, Application of IC Engines **4 Hrs**
2. **Air Standard Cycles and their analysis:** Carnot Cycle, Stirling Cycle, Ericson Cycle, Otto Cycle, Diesel cycle, Dual Cycle, Brayton Cycle, Comparison of Otto, Diesel and Dual Cycles. **6 Hrs**
3. **Fuel Air Cycles and their analysis:** Introduction to fuel air cycles and their significance, composition of cylinder gases, variable specific heats, Dissociation, effect of no. of moles, comparison of air standard& fuel air cycles, Effect of operating variables, Comparison of actual and air standard cycles. **6 Hrs**
4. **Fuels:** Solid, liquid and gaseous conventional fuels, combustion equation for hydrocarbon fuels, determination of minimum air required for combustion, conversions of volumetric analysis to mass analysis, qualities of S.I. & C.I. Engine fuels and their rating, types of Alternative Fuels. **8 Hrs**

Part-B

5. **Carburetion:** Principle of carburetion, factors affecting carburetion, mixture requirements at different loads and speeds, the simple/ideal carburetor, Essential parts of carburetor, analysis of single jet carburetor, compensating devices. **6Hrs**
6. **Fuel Injection Systems:** functional requirements of an injection system, Mechanical injection system and its components, Injection in SI Engine, Electronic fuel injection system, MPFI system, and Electronic diesel injection system. **7Hrs**

7. **Combustion and combustion chambers:** Stages of Combination in SI and CI Engines, Flame front propagation, factor influencing the flame speed, ignition lag and factors affecting the lag, Abnormal combustion and knocking, different combustion chambers for SI and CI Engines, Concept of supercharging and Turbocharging. **5 Hrs**
8. **Measurement and Testing:** Measurement of friction horse power, brake horse power, indicated horse power, measurement of speed, air consumption, fuel consumption, heat carried by coolant and exhaust gases, performance parameters and characteristics **6 Hrs**

Text Books:

1. Heywood, John B. Internal combustion engine fundamentals. McGraw-Hill Education, 2018.
2. Stone, Richard. Introduction to internal combustion engines. Vol. 3. London: Macmillan, 1999.
3. Ferguson, Colin R., and Allan T. Kirkpatrick. Internal combustion engines: applied thermosciences. John Wiley & Sons, 2015.
4. Ganesan, V. Internal combustion engines. McGraw Hill Education (India) Pvt Ltd, 2012.
5. V. M. Domkundwar, A Course in Internal Combustion Engines 2nd edition, Dhanpat Rai & Co., 2016.

Reference Books:

1. Pulkrabek, Willard W. *Engineering fundamentals of the internal combustion engine*. Prentice hall of India, 2000.
2. Malik, Ashish, and S. K. Mohapatra. "Biomass-based gasifiers for internal combustion (IC) engines." *Sadhana* 38.3 (2013): 461-476.

List of Open Source Software/learning website:

1. http://nptel.ac.in
2. http://ocw.mit.edu

Subject Code: PEME-102 **Subject Name: Cryogenic Technologies**

Programme: B.Tech(ME).	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 40-50
External Marks: 60	**Duration of End Semester Exam (ESE):** 03hours
Total Marks: 100	**Course Status:** Elective VI

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Evaluate cryogenic processes in details
2.	Understand the processes of cryogenic liquid production and their storage
3.	Analyze the effect of cryogenic manufacturing on material properties.
4.	Analyze with various cryogenic refrigeration cycles.
5.	Understand type of cryogenic insulation used during cryogenic manufacturing
6.	Design cryogenic manufacturing system for various applications

Detailed Contents:

Part-A

1. **Introduction to Cryogenic Manufacturing:** Historical perspective and origin of cryogenic material manufacturing Need of cryogenic manufacturing, Types of low temperature treatment and processors, Advantages and disadvantages of cryogenic manufacturing, applications of cryogenic manufacturing. **6 Hrs**
2. **Cryogenic Liquid:** Definition and its types, storing cryogenic liquids, various cryogenic fluids and their properties, health, chemical and flammability hazards of cryogenic liquids, liquid nitrogen production, liquid helium Production, cryogenic oxygen plant. **6 Hrs**
3. **Material Behavior in Cryogenic Manufacturing:** Behavior and performance of materials during cryogenic manufacturing, effect on material properties (mechanical, thermal, and electrical,Super conductivity), effect on formability of materials, impact of cryogenic processing on product performance. **7Hrs**
4. **Cryogenic Processes:** Cryogenic machining, cryogenic grinding, Cryogenic deflashing, Cryogenic deburring, Cryogenic rolling, and cryogenic cooling systems: Materials, machines and tooling, cryogenic machining of elastomers, economic aspects of cryogenic processing. **7 Hrs**

Part-B

5. **Cryogenic Refrigeration:** Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, cold gas refrigerators, Linde,Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Gifford single volume refrigerator, Pulse tube refrigerators. **8 Hrs**
6. **Cryogenic Insulations:** Various types such as expanded foams, gas filled& fibrous insulation, vacuum insulation, evacuated powder& fibrous insulation, opacified powder insulation, multi layer insulation, comparison of performance of various insulations. **8 Hrs**
7. **Applications of Cryogenic Engineering:** Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation,

cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions **6 Hrs**

Text Books:

1. Jha, Asu Ram. Cryogenic technology and applications. Elsevier, 2011.
2. Done, Robert. "Introduction to general health and safety." The Safe Use of Cryogenic Technologies.2016.
3. Mukhopadhyay, Mamata. Fundamentals of cryogenic engineering. PHI Learning Pvt. Ltd., 2010.
4. Flynn, Thomas. Cryogenic engineering revised and expanded. CRC Press, 2004.
5. Timmerhaus, Klaus D., and Thomas M. Flynn. Cryogenic process engineering. Springer Science & Business Media, 2013.

Reference Books:

1. Kalia, Susheel, and Shao-Yun Fu, eds. *Polymers at cryogenic temperatures*. Berlin, Heidelberg: Springer, 2013.
2. Donabedian, Martin. *Spacecraft thermal control handbook, volume II: cryogenics*. American Institute of Aeronautics and Astronautics, Inc., 2004.

Subject Code: PEME-105 **Subject Name: Fluid Dynamics**

Programme: B.Tech.(ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 6th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:**40-50
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Course Status:** Elective II

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO #	Course Outcomes
1.	Understand the concept of potential flow theory and its application to flow.
2.	Calculate the theoretical Lift force for cylindrical and other shaped bodies.
3.	Apply Plain Couette flow to hydro-dynamic lubrication.
4.	Analyze Boundary layer stress and velocity distribution and drag forces
5.	Evaluate the various forces on immersed bodies and effect of streamlining.
6.	Understand the compressible flow, Mach number, and Stagnation properties.

Detailed Contents:

Part-A

1. **Potential Flow:** Stream function and velocity potential functions for standard flow patterns uniforms flow, source/sink, doublet and free vortex ; combination of uniform flow with certain flows to obtain flow patterns of various shapes such as flow past a half body, a cylinder, a Rankine oval body, and a cylinder with circulation : Kutta - Joukowski Theorem - lift on a cylinder. **9 Hrs**
2. **Viscous Flow:** Navier Stokes equation of motion; Relationship between shear stress and pressure gradient; two dimensional laminar flow between two fixed parallel planes ; Plain Couette flow and its application to hydro-dynamic theory of lubrication. **7Hrs**
3. **Turbulence:** concept and understanding of turbulent flows, Fluctuation in velocity; intensity and scale of turbulence; Reynolds equations and turbulence modeling (RANS). **06 Hrs**

Part-B

4. **Boundary Layer:** Salient features of flow pattern in a boundary layer; Velocity and shear stress distribution along the boundary; Quantitative correlation for boundary layer thickness, local skin friction coefficient and drag coefficient in laminar, turbulent and laminar turbulent combined boundary layer flows on a flat plate without pressure gradient; Von-Karman momentum integral equation, flow over a curved surface boundary layer separation and its control. **08 Hrs**
5. **Flow around Immersed Bodies:** Concept of friction, pressure, wave and induced drag- lift and drag coefficients; variation of drag coefficient with Reynolds number for two dimensional bodies (flat, cylinder, and sphere). Vortex shedding from cylindrical bodies; effect of streamlining; Terminal velocity; Lift generation from airfoil section; Kutta Condition and Kelvin's Circulation Theorem, Downwash and induced drag. **09 Hrs**
6. **Compressible Flow:** Wave propagation and sonic velocity; Mach number, Limits of incompressibility and compressible flow regimes; pressure field due to a moving source of disturbance, Mach cone and Mach angle. Basic equations for one-dimensional compressible flow; static and stagnation values; Isentropic flow relations; flow through a duct of varying

cross-section, mass flow rate and choking in a converging passage. Normal shock and change in flow properties across a normal shock wave. **09 Hrs**

Text Books:

1. Cengel, Yunus A., and John M. Cimbala. "Dimensional analysis and modeling." *Chapter* 7 (2014): 301.
2. John.D. Anderson, Fundamentals of Aerodynamics, McGraw Hill, 5th Edition , 2011
3. F rank.M. White, Viscous Fluid Flow, McGraw Hill, 3rd Edition, 2011
4. H. Schlichting "Boundry Layer Theory", Springer Berlin Heidelberg, 8th Edition , 2014
5. S.K. Som , G. Biswas , and S. Chakraborty "Introduction to Fluid Mechanics" by , McGraw Hill, 2nd Edition , 2004.

Reference Books:

1. D.S. Kumar "Fluid Mechanics and Fluid power Engineering", S.K. kataria Publications, 8th Edition, 2013.
2. Oh, Hyoung Woo, ed. Applied computational fluid dynamics. BoD–Books on Demand, 2012.

Subject Code: PEME-106 **Subject Name: Heat Exchanger Design**

Programme: B.Tech(ME).	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 40-50
External Marks: 60	**Duration of End Semester Exam (ESE):** 03hours
Total Marks: 100	**Course Status:** Elective V

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Understand the physics and the mathematical treatment of typical heat exchangers
2.	Apply LMTD and NTU methods in the design of heat exchangers
3.	Analyze effectiveness of heat exchangers
4.	Design and analyze the shell and tube heat exchanger
5.	Apply the principles of boiling and condensation in the design of boilers and condensers
6.	Design cooling towers from the principles of psychrometry

Detailed Contents:

Part-A

1. **Introduction to Heat Exchangers:** Definition, Applications, Various methods of classification of heat exchangers with examples. Derivation of governing equation for heat exchangers from steady-state steady-flow considerations. Concept of Overall Heat Transfer Coefficient, Fouling, Fouling Factor, Factors contributing to fouling of a heat exchanger, Ill-Effects of fouling, Numerical Problems. **8 Hrs**
2. **Concept of Mean Temperature Difference:** Expression for single-pass parallelflow and single-pass counter flow heat exchangers – Derivation from first principles, Special Cases, LMTD for a single-pass cross-flow heat exchanger – Nusselt's approach, Chart solutions of Bowman et al. pertaining to LMTD analysis for various kinds of heat exchangers, Numerical Problems, Arithmetic Mean Temperature Difference [AMTD], Relation between AMTD and LMTD, Logical Contrast between AMTD and LMTD, LMTD of a single-pass heat exchanger with linearly varying overall heat transfer coefficient [U] along the length of the heat exchanger. **8 Hrs**
3. **Effectiveness of heat exchangers:** Effectiveness-Number of Transfer Units Approach, Effectiveness of single-pass parallel-flow and counter- flow heat exchangers, Physical significance of NTU, Heat capacity ratio, Different special cases of the above approach, Chart solutions of Kays and London pertaining to Effectiveness-NTU approach, Numerical Problems. **8 Hrs**

Part-B

4. **Shell and Tube Heat Exchangers:** Single-Pass, One shell-Two tube [1S-2T] and other heat exchangers, Industrial versions of the same, Classification and Nomenclature, Baffle arrangement, Types of Baffles, Tube arrangement, Types of tube pitch lay-outs, Shell and Tube side film coefficients, Pressure drop calculations, Numerical Problems. **8 Hrs**

5. **Principles of Boilers and Condensers:** Boiling, Fundamentals and Types of boiling – Pool boiling curve, various empirical relations pertaining to boiling, Numerical problems on the above, Condensation – Classification and Contrast, Types of condensers, Nusselt's theory on laminar film-wise condensation, Empirical Refinements, Several empirical formulae, Numerical problems. **8 Hrs**
6. **Cooling Towers**: Cooling towers – basic principle of evaporative cooling, Psychrometry, fundamentals, Psychrometric chart, Psychrometric Processes, Classification of cooling towers, Numerical problems. **8 Hrs**

Text Books:

1. K. Thulukkanam, Heat Exchanger Design Handbook, Taylor & Francis, 2000.
2. S. Kakac and H. Liu, Heat Exchangers: Selection, Rating, and Thermal Design, Third Edition, CRC-Press, 1998.
3. R. K. Shah and D. P. Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons, 2003.
4. Shah, Ramesh K., and Dusan P. Sekulic. Fundamentals of heat exchanger design. John Wiley & Sons, 2003.
5. Gupta, Jai Prakash. "Fundamentals of heat exchanger and pressure vessel technology." (2016).

Reference Books:

1. Frank P. Incropera and David P. Dewitt, Fundamental of Heat and Mass Transfer, Wiley India, 2002.
2. Kays, W. M. and London, A. L., Compact Heat Exchangers, 2nd Edition, McGraw – Hill, New York.

Online notes:

1. https://nptel.ac.in/courses/112/105/112105248/ on Nov 2021

Subject Code: PEME-107 **Subject Name: Solar Energy**

Programme :B-Tech. (ME)	**L: 4 T: 0 P: 0**
Semester: 7th /8th	**Teaching Hours:48**
Theory/Practical: Theory	**Credits:4**
Internal Marks: 40	**Percentage of numerical/design/programming problems:10-20**
External Marks: 60	**Duration of end semester exam: 3 hrs**
Total Marks: 100	**Course Status : Elective III**

On completion of subject students will have the ability to:

CO#	Course Outcomes(CO)
1	Fundamentals of solar radiations and measurement techniques
2	Identify different methods of calculation of solar radiation availability at a given location
3	Make critical comparison of different solar energy systems
4	Explain the technical and physical principles of solar cells and solar collectors
5	Calculate load for energy conversion devices and solar energy sources.
6	Understand how and where to implement solar energy sources for solar energy to electricity conversion.

Detailed Content:

Part-A

1. **Solar Flux and Weather Data**: Introduction, Solar Constant, Spectrum of sun, Diurnal Variation of Direct Sunlight, Height variation of direct sunlight. Standard atmosphere, 'Zenith Distance Flux Variation, Geographical distribution of sun-shine and effects of weather on Solar Flux. Introduction to solar Flux observation, Instruments such as pyranometer, Phyrheliometer and Sunshine Recorder, Correlation between direct and total Insulation, Solar flux variation dynamic, Correlation of sunshine with Wind Velocity, Environmental Thermal Infrared Flux and ETIR Model. **4Hrs**
2. **Solar Radiation Availability**: Introduction, Zenith Distance Vs time, Time of sunrise and sun-set fully Tracking collector, Variation of flux curves with latitude and geometry, Introduction tom Fixed Flat plate (horizontal, latitude Tilted, fixed latitude + 15°, Vertical South-facing, seasonally Tilted) N-S and horz, east west tracking and N-S polar east west tracking, East west horz and N-S tracking, Comparison of theoretical curves with observation, comparison of daily output; Peak flux Vs Average flux. **6Hrs**
3. **Heat Transfer in Solar Collectors:** Introduction, Heat Losses in a Distributed Collector system. The Liquid Transfer Module System, Solar Heat Availability, Fluid Mechanics, Fluid Properties, Temperature Rise, Solar Flux, Pressure Drop Relations, Reynolds Number, Ratio of Power Expended to Power Generated, Magnitude of Power Output/Input Ratio, Parametric Relationships for Fluid Transfer, Variation of Output/Input Ratio with Solar Flux. Air-Transfer Systems, Air Heat Transfer in Terms of Volume Rate of Flow, Typical Evaluation Situation. Alternative Forms of the HeatRise Equation, Effect of Changing Heat-Transfer Fluid, Heat Transfer in Evacuated Collectors, Thermodynamic Utilization of Collected Energy, Evacuated Collectot Trade offs. Linear Absorber with Air Radiation Suppression Using Honeycombs Convection Suppression Using Honey-combs, Heat Pipes, Heat Transfer alongh Thin Sheets, Differential Thermal Expansion, Problems. **10Hrs**

Part-B

4. **Flat-Plate Collectors:** Introduction, Basic Collector Configurations, Diurnal Temperature, Profile, Thermal Inertia UFactor, Collector Heat Balances. Sample Calculation, Surface Temperature. Efficiency versusTemperature Curves, General Properties of an efficiency Vs Change and Temperature, The Bare Collector; Single –Window Collector, Double Window Collector Improvement of Performance, Geometrical Suppression of Convection, Window Temperature. Effect of Selective Absorber Surface, Selective Windows Facing Selective Surface Combination of Absorber and selective windows, Comparison of Thermal Behaviour for Selective Windows, Window Absorption Non reflection Coated Window, Variation of Efficiency with Solar Flux, Evacuated, Cooling, Selective Radioactive Cooling, Cylindrical Collector Structure Flat-Plate .Collector performance, Solar Ponds, Problems **10Hrs**
5. **Energy Storage**: Introduction, Basic System Diagram, Peaking Effect of Back up Demands, Energy Storage, Hydrostorage Chemical Batteries Flywheels Chemical Storage, Compressed Air, Biological Storage, Thermal Storage, Sensible-Heat Storage, Latent-Heat Storage, Salt Eutectics, Zoned Thermal Storage Fluid Tank, Rock Thermal Storage Tank, Thermal Storage Tank Farm, Heat Management with and without Phase Change, Thermal inertia, Calculation of Detailed Performance, Problems. Application of Solar Energy (History and Survey Application) Community Heating & Cooling system, Solar Water pumping, solar gas absorption refrigeration, MEC Cooling system, Two stage evaporative cooling etc. **10Hrs**
6. **Direct Conversion to Electricity:** Introduction, Direct conversion by Means of Solar Cells, Silicon Cells, Manufacture of Silicon Cells, Efg Ribbon Silicon Cells Polycry Stalline silicon cells, Cadmium sulfide Solar Cells, Manufacture of Cadmium Sulfide Cells Gallium Arsenide Solar Cells, Thermal Behaviors of Solar Cells Cooled Solar Cells for Concentrating System. Thermo-electric Solar Cells, Thermonic Solar Cells, Phase-Change Thermal Direct Conversion, Problems. **8Hrs**

Text Books

1. Aden B.Meinel and Marjoric P.Meinel, An Introduction to Applied Solar Energy, Addison Wesley.
2. Jan F.Kreider and Fran Kreith, Hand Book of Solar Energy, McGraw-Hill.
3. M. Stix, The Sun, An Introduction, Second Edition, Springer.
4. Nelson, The Physics of Solar Cells, Imperial College Press.
5. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi.

Reference Books:

1. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co., 3rd Edition.
2. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, Sixth Edition, Prentice Hall.

Subject Code: PEME-108 **Subject Name: Power Plant Engineering**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Subject Status:** Elective IV

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand energy sources for power generation and principles types of power plants.
2	Compare essential features and types of hydro-electric and nuclear power plant.
3	Understand about essential features of steam power plant and also have knowledge about coal and ash handling systems.
4	Compare I.C engines and its performance with other plants.
5	Evaluate of load factor, capacity factor, average load and peak load on power plant.
6	Analyze and give suggestion for direct energy conversion systems.

Detailed Contents:

Part-A

1. **Introduction:** Energy sources for generation of electric power, Principles types of power plants-their special features and applications, Present status and future trends. **05 Hrs**

2. **Hydro-Electric Power Plants:** Hydrograph, Flow duration curve, Essential features, layout of hydro Power Plant, Classifications, Hydroelectric survey, rainfall run-off, storage capacity, Site selection. **06 Hrs**

3. **Steam Power Plant:** General Introduction, Essential features, Site Selection, Coal handling, feeding and burning, Fluidised bed combustion, Ash handling, dust collection, High pressure boilers, Economisers, Super heaters, Air pre heaters. **07 Hrs**

4. **Diesel and Gas Turbine Power Plants:** Classification of IC engines, Four stroke and two stroke diesel engines, Combustion phenomenon, Supercharging, Plant layout, Comparison with steam power plants. **06 Hrs**

Part-B

5. **Nuclear Power Plant:** Nuclear fuels, nuclear energy, Nuclear reactions, Main components of nuclear power plant, Nuclear reactors-types and applications, Site selection, radioactive waste disposal, Safety aspects, Future of Nuclear power. **06 Hrs**

6. **Power Plant Economics:** Terms and conditions, Effect of load on power plant design, methods to meet variable load, prediction of load. Non-Conventional Power Generation: Biomass Energy: Biomass Production, Biomass Gasification, Biogas and its Composition, Biogas Production and Benefits. Geothermal power plants, Tidal power plants, Wind power plants, solar power plants, Electricity from city refuge. **10 Hrs**

7. **Direct Energy Conversion Systems:** Thermoelectric conversion system, Thermionic conversion system, Photo voltaic power system, Fuel Cells, Magneto-hydrodynamic system.

08 Hrs

Text Books

1. P.K. Nag, "Power Plant Engineering", Tata McGraw Hill, 2nd Edition, 2002.
2. G.R. Nagpal, "Power Plant Engineering", Khanna Publishers, 16th Edition, 2013.
3. S.C. Arora, S. Domkundwar, "Power Plant Engineering", Dhanpat Rai, 6th Edition, 2013.
4. R.K. Rajput, "Power Plant Engineering", Luxmi Publications, 4th Edition, 2008.
5. P.C Sharma, "Power Plant Engineering", Kataria & Sons, 1st Re-print 2016.

Reference Books:

6. Acha, Enrique, and Manuel Madrigal. Power System Harmonics: computer modelling and analysis. John Wiley, 2001.
7. Rasul, Mohammad, ed. Thermal Power Plants: Advanced Applications. BoD–Books on Demand, 2013.

Subject Code: PEME-109 **Subject Name: Computational Fluid Dynamics**

Programme: B.Tech.(ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:**40-50
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Course Status:** Elective IV

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO #	Course Outcomes
1.	Understand the concept of numerical modeling, applications of CFD to various engineering fields.
2.	Apply conservation principles to derive various flow-governing equations, their mathematical nature and various boundary conditions.
3.	Understand basic discretization techniques: finite difference and finite volume methods.
4.	Analyze various numerical schemes: concept of consistency, stability and convergence, error and stability analysis.
5.	Solve linear algebraic equations by TDMA, QUICK scheme, SIMPLE algorithm for various types of fluid flow problems.
6.	Run 1-D/2-D flow simulations on available commercial/open source software.

Detailed Contents:

Part-A

1. **Introduction to CFD:** Basic concept of Computational Fluid Dynamics, CFD Applications, Numerical, Analytical and Experimental investigations, working of CFD code, and introduction to commercially available CFD software. **7Hrs**
2. **Governing flow equations:** Principles of conservation, Conservation of mass, momentum and energy. Navier-Stokes equation and General scalar transport equation. Mathematical classification of Partial Differential Equations (PDEs) and their physical meaning, well posed boundary value problems, and possible types of boundary conditions. **7Hrs**
3. **Fundamental of Discretization:** Nature of numerical methods**,** concept and basic rules for Discretization, Grid generation techniques.Concept of consistency, accuracy, stability and convergence, error and stability analysis. **8 Hrs**
4. **Discretization Approaches:** Finite Difference Method (FDM) Taylor series expansion (1^{st} and 2^{nd} order) and Finite volume method (FVM). One-Dimensional Steady State Diffusion/Diffusion-convection Problems: Source term linearization, Implementation of boundary conditions, Upwind/linear interpolation, and quadratic upwind interpolation (QUICK). **8 Hrs**

Part-B

5. **Solution of Systems of Linear Algebraic Equations:** Criteria for unique solution, infinite number of solutions and no solution, Guass Elimination method: Forward elimination and backward substitution, L-U decomposition technique, Tri diagonal matrix algorithm (TDMA): Thomas algorithm, Iteration methods: Jacobi's method and Gauss Siedel method.

8Hrs

6. **Navier Stokes Equations:** Discretization of convective, viscous, pressure and body terms, staggered grid, and SIMPLE Algorithm. **10Hrs**

Text Books:

1. Suhas V. Patankar, " Numerical Heat transfer and Fluid Flow," Taylor and Francis
2. H.K. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics, The finite volume approach" Pearson Publishing House, 2nd edition 2007
3. John D. Anderson Jr., "Computational Fluid Dynamics the basics with applications", Mcgraw Hill, 1st edition, 1995
4. J.H. Ferziger and M. Peric, "Computational Methods for Fluid Dynamics", Springer Publisher, 3rd edition, 2002
5. Charles Hirch, " Numerical Computation of Internal and External Flow", Butterworth-Heinemann (Elsevier) Publisher, 2nd edition, 2007

Reference Books:

1. Anderson, John David, and J. Wendt. Computational fluid dynamics. Vol. 206. New York: McGraw-Hill, 1995.
2. Lomax, Harvard, et al. Fundamentals of computational fluid dynamics. Vol. 246. Berlin: Springer, 2001.

E-Books and online learning material:

1. http:// www.cfd-online.com
2. https://www.ansys.com/en-in/academic/free-student-products

Online Courses and Video Lectures:

https://nptel.ac.in/courses/cfd [Access Date: 25-02-2020]

CFD video course by Prof. S.chakraborty, Department of Mechanical Engineering IIT Kharagpur
CFD video course by Prof. Gautam Biswas IIT Kanpur,
CFD video course by Prof. M.Ramakrishna, Department of Aerospace Engineering IIT Madras
CFD video course by Prof. K.M.Singh, Department of Mechanical Engineering IIT Roorkee

Subject Code: PEME-111 **Subject Name: Gas Dynamics**

Programme: B.Tech.	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 20-30
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective V

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Understand basic concept and importance of gas dynamics
2.	Analyze the basic fundamental equations of one dimensional flow of compressible fluid and isentropic flow of an ideal gas.
3.	Analyze the steady one-dimensional is entropic flow; frictional flow and isothermal flow and express the concepts of steady one dimensional flow with heat transfer.
4.	Evaluate the effect of heat transfer on flow parameters.
5.	Compare the jet propulsion engines.
6.	Design basic structure of rocket propulsion.

Detailed Contents:

Part-A

1. **Introduction to Gas Dynamics:** Control volume and system approaches acoustic waves and sonic velocity- Mach number classification of fluid flow based on Mach number-Mach cone-compressibility factor - General features of one dimensional flow of a compressible fluid - continuity and momentum equations for a control volume. **7Hrs**

2. **Isentropic Flow of an Ideal Gas:** Basic equation-stagnation enthalpy, temperature, pressure and density-stagnation, acoustic speed-critical speed of sound dimensionless velocity-governing equations for isentropic flow of a perfect gas - critical flow area **6Hrs**

3. **Steady One Dimensional Isentropic Flow:** nozzles area change effect on flow parameters, chocking, convergent nozzle performance of a nozzle under decreasing back pressure. Delavel nozzle - optimum area ratio, effect of back pressure - nozzle discharge coefficients, nozzle efficiencies. **8Hrs**

Part-B

4. **Simple Frictional Flow:** Governing equations for Adiabatic flow with friction in a constant area duct-fan no line limiting conditions, effect of wall friction flow properties in an Isothermal flow with friction in a constant area duct governing equations - limiting conditions, numerical problems. **9Hrs**

5. **Steady One Dimensional Flow with Heat Transfer:** Governing equations- Rayleigh line entropy change caused by heat transfer - conditions of maximum enthalpy and entropy. **8Hrs**

6. **Effect of Heat Transfer on Flow Parameters:** Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas-properties of flow across a normal shock-governing equation –

Rankine Hugoniat equations- Prandtl's velocity relationship- converging diverging nozzle flow with shock thickness–shock strength. **10Hrs**

Text Books:

1. John Anderson, Modern Compressible flow, McGraw Hill-2003.
2. H. Cohen, G.E.C. Rogers and Saravanamutto, Gas Turbine Theory, Longman Group Ltd.-1980.
3. S. M.Yahya ,Fundamentals of compressible flow with aircraft and rocket propulsion, New Age International (P) Ltd.-2007
4. N.J. Zucrow ,Principles of Jet Propulsion and Gas Turbines, -John Wiley, NewYork,-1970.
5. Zucrow ,Aircraft & Missile propulsion, -Wiley,New York-1958

Reference Books:

1. A. H. Shapiro, Compressible fluid flow, by -The Ronald Press, New York-2002
2. Liepman & Roshko, Elements of gas dynamics, Wiley, NewYork-1957

Subject Code: PEME-201 **Subject Name: Design for X**

Programme: B.Tech.(ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 7^{th} /8^{th}	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Elective III

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Analyse and come up with solutions based on the engineering design aspects.
2	Identify the need to analyse the engineering design aspects that should be considered.
3	Design for manufacturing and assembly (DFMA), design for additive manufacturing, robust design, design for environment (DfE)
4	Manage the production of the necessary basis for a previously unknown "X"
5	Design solution that has been developed and based on that, be able to offer recommendations for further and/or alternative design solutions.
6	Analyses of the proposal that has been developed, including further development of the available DfX data.

Detailed Contents:

Part-A

1. **Introduction:** Concept of Design for Manufacturing and assembly, Concurrent Engineering, Review of Classification of manufacturing process, Basic manufacturing processes, Mechanical properties of material: Tensile properties, Engineering stress-strain, True stress strain, Compression properties, Shear properties, Introduction to materials and material selection: Classification of engineering materials, Material selection for product design **07 Hrs**
2. **Design for Manufacturing (DFM):** Steps and advantages of applying DFM during product design. Design considerations for Machining, Sheet Metal working, Die Casting, Powder Metal Processing, Sand Casting, Investment Casting, Forging.
3. **Intigrating DFM with CAM:** General Considerations for Linking CAD and DFMA Analysis, Geometric Representation Schemes in CAD Systems, Design Process in a Linked CAD/DFMA Environment, Extraction of DFMA Data from CAD System Database, Expert Design. **12Hrs.**

Part-B

4. **Design for Assembly (DFA):** Development of the Systematic DFA Methodology, Assembly Efficiency, General Design Guidelines for Manual and Automatic Assembly, Effect of Part Symmetry on Handling Time, Effect of Part Thickness and Size on Handling Time, Effect of Weight on Handling Time, Types of Manual Assembly Methods, Applying Learning Curves to the DFA Times, Design for High-Speed Automatic Assembly and Robot Assembly **10 Hrs**

5. **Design for Environment (DFE):** Need for DFE increasing levels of pollution, diminishing raw material resources and overflowing of waste sites. Need for integrating environmental issues into new product development including design, material selection, manufacturing processes and delivery of product to consumers. End-of-life management of product after its useful life. Life cycle of products, disassembly, material recovery, remanufacturing and pollution prevention. **10 Hrs**

6. **Case Studies** on DFM (Machine parts), DFA (Automobile industry), DFMA and DFE.**09 Hrs**

Text Books

1. Boothroyd, G., Dewhurst, P., & Knight W.: Product Design for Manufacture and Assembly. M. Dekker, 2002, ISBN: 0-8247-0584-X. DFMA, e-book available via the Lund University Library homepage.
2. Ehrlenspiel, K., Kiewert, A., & Lindemann, U.: Cost-Efficient Design. Springer, 2007, ISBN: 978-3-540-34647-0. DFMA, e-book available via the Lund University Library homepage.
3. Ulrich, K.T., & Eppinger, S.D.: Product Design and Development. McGraw-Hill. Robust design, chap. 12 (2008, 4th ed.) or chap. 13 (2012, 5th ed.).
4. Jiju, A.: Design of Experiments for Engineers and Scientists. Elsevier, 2003, ISBN: 978-0-7506-4709-0. Robust Design, chap. 6, e-book available via the Lund University Library homepage.
5. Lunau S. et al.: Design for Six Sigma+Lean Toolset. Springer, 2013, ISBN: 978-3-642-41455-8. Robust design, e-book available via the Lund University Library homepage.

Reference Books:

1. Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., "Mechanical Engineering Design", 10thEdition, Tata McGraw-Hill, 2014.
2. Khurmi R.S. and Gupta J.K.,"Machine Design", S. Chand Publishing Co., 1st Multicolor edition , 2014

Subject Code: PEME-203 **Subject Name: Machine Tool Design**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 7th/8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Subject Status:** Elective IV

Prerequisites: NIL.

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the various requirements of the machines.
2	Design various feed drives and spindle drives design on the basis of varying load conditions.
3	Enhance the knowledge regarding the manufacturing aspects of the machining.
4	Analyze machine tool dynamics.
5	Evaluate the purpose and principal of tool geometry, construction and design.
6	Design machine tools control system which will further help in recognizing the different operational conditions on the machine.

Detailed Contents:

Part-A

1. D**ata Calculation:** Turning: Cutting force, Cutting Speed and Feed Rate. Drilling: Cutting forces, Cutting Speed and Feed Rate. Milling: Chip Section, Cutting force, Milling with Cutter Heads. Grinding: Grinding Forces, Cutting Speed, Feed Rate, and Depth Setting. Planning, Shaping and Broaching. **03 Hrs**
2. **General Requirements of the Machine Tool:** Accuracy of Shape, Dimensional accuracy and surface finish of the components produced. High Productivity. High Technical and Economic Efficiency. **04 Hrs**
3. **Design Principles:** Stiffness and Rigidity of the Separate Constructional Elements and their combined behavior under Load, Static Rigidity, Dynamic Rigidity, Natural frequencies, Damping, Mode of Vibration. **04 Hrs**
4. **Standardization of Spindle Speeds and Feed Rates:** Layout of Speed Change Gears. Saw Diagrams for Arithmetic Progression, Geometric Progression, Harmonic Progression and Logarithmic Progression of spindle speeds for Mechanical Stepped Drives for Machine Tools. Establishment of Gear Ratios, Layout of the Intermediate Reduction Gears, Calculation of Transmission Ratios, Pulley Diameter, Gear Wheel Diameters and Number of Teeth. Ray Diagram. Speed Diagram. **06 Hrs**
5. **Electrical, Mechanical and Hydraulic Drives for the Operational Movements:** Electric Drive and Control Equipment. Mechanical and Hydraulic Drives. Drives for Producing Rotational Movements, Stepped Drives, Step less Drives. Drives for Producing Rectilinear Movements. Backlash Eliminator in the Feed Drive Nut. **06 Hrs**

Part-B

6. **Automatic Control:** Principles and Constructional Elements. Automatic Driving of the Cutting Movements, Feed Movements, and Return Movements. Automatic control of movements for Starting, Stopping and Reversing. Automatic Clamping and Unclamping the work piece. Automatic Selection of Required Speeds, Automatic Setting of Tools. Automatic Measurement of Machined Shape and Surfaces. Transport of Components from One Machine to the Next. Applications (Examples of Automatic Machines). Control for Moving Slides into Defined, Fixed Positions. Control of Feed Movements in Producing Profiles or Surface by Continuous Path Control **08 Hrs**
7. **Design of Constructional Elements:** Machine Tool Structures, Structural Elements Design for Centre Lathe, Drilling Machine, Knee Type Milling Machine, Planning Machine, Boring Machine, and Grinding Machines. **06 Hrs**
8. **Design of Slide Ways:** Design of Slide ways for Tables, Saddles and Cross-slides. Antifriction Bearings for slide ways. Hydrostatically Lubricated Slide ways. **06 Hrs**
9. **Design of Spindles and Spindle Bearings:** Design of Spindles for Strength and Stiffness. Design of Spindles for Balancing. General Layout and Design of the Driving Elements and the Spindle Bearings. Selection and General Layout of Ball and Roller Bearings for Supporting Spindles. Design of Secondary Drives for Machine Tools, Design of Cutting Drives, Feed Drives and Setting Drives. **05Hrs**

Text Books

1. Sen and Bhattacharya, "Machine Tools Design", CBS Publisher.
2. N.K. Mehta, "Machine Tool Design", Tata McGraw Hill.
3. N. Acherkan, " Machine Tool Design, Four Volumes" ,Mir Publishers.
4. P. H. Joshi, " Machine Tools Handbook*:* Design and Operatio*n*", McGraw Hill Professional.
5. S.K. Basu and D.K. Pal, "Design of machine tools", Oxford and IBH.

Reference Books:

1. Koenigsberger, Franz, and Jiri Tlusty. Machine tool structures. Elsevier, 2016.
2. Altintas, Yusuf. Manufacturing automation: metal cutting mechanics, machine tool vibrations, and CNC design. Cambridge university press, 2012.

Subject Code: PEME-205 **Subject Name: Experimental Stress Analysis**

Programme: B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Subject Status:** Elective VI

Prerequisites: NIL.

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand and explain the elastic behaviour of solid bodies.
2	Apply the photo elastic techniques to characterize the elastic behaviour of the solids.
3	Apply coatings techniques to determine stresses and strains.
4	Describe stress strain analysis of mechanical systems using electrical resistance strain gauges.
5	Apply experimental methods of determining stresses and strains induced.
6	Analyse and reduce the brittle coating defects.

Detailed Contents:

Part-A

1. **Basic elasticity:** Laws of stress transformation, principal stresses and principal planes. Cauchy's stress quadric strain analysis, strain equations of transformation, Cauchy's strain quadric, stress, strain relationship. **5Hrs**

2. **Two Dimensional photo-elasticity:** Stress optics law, Optics of polarization plane and circular polariscope, dark and light field arrangements, fringe multiplication, fringe sharp ending, compensation techniques, commonly employed photo elastic materials. **7Hrs**

3. **Dimensional photo-elasticity;** Neuman's strain optic relationship, stress freezing in model materials for 3-D photo-elasticity, shear difference method for stress separation. **8 Hrs**

Part-B

4. **Birefringence coatings:** sensitivity, reinforcing effects, thickness of birefringence coatings. **6 Hrs**

5. **Electric resistance strain gauges:** Gauge construction and installation, temperature compensation, gauge sensitivities, gauge factor, corrections for transverse strain effects, factors affective gauge relation, rosetters Rosetre analysis, potentiometer and whetstone's bridge circuits for strain measurements. **11 Hrs**

6. **Brittle coatings:** Introduction, coating stresses and failure theories, different types of crack patterns, crack detection composition of brittle coatings, coating cure, influence of atmospheric conditions, effects of biaxial stress field. **11 Hrs**

Text Books:

1. Dally and Rilley, Experimental Stress Analysis ; McGraw Hill
2. Dow and Adams, Experimental Stress Analysis and Motion Measurement, Prentice Hall
3. Durelly and Riley, Introduction to Photo Mechanics, Prentice Hall.
4. Srinath L.S, Experimental stress Analysis, tata Mc Graw Hill.
5. Sadhu Singh, Experimental stress Analysis, Khanna publisher.

Reference Books:

1. GS Holister. Experimental stress analysis: principles and methods. CUP Archive, 1967.
2. Doyle, James F. Modern experimental stress analysis: completing the solution of partially specified problems. John Wiley & Sons, 2004.

Subject Code: PEME-206 **Subject Name: Industrial Tribology**

Program: B.Tech.(ME)	**L:** 4 **T:** 0 **P:** 0
Semester: $7^{th}/8^{th}$	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Elective IV

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Understand the surface and sub-surface constituent layers in engineering materials.
2	Analyze various methods for quality checking of engineering applicable surfaces.
3	Understand the theories and rigs accounting friction and Wear.
4	Analyze the variation of friction and wear in metals and non-metals.
5	Apply various lubrication systems and bearing for different working conditions.
6	Analyze causes of failure of tribological components.

Detailed Contents:

Part-A

1. **Introduction:** Tribological considerations, Application of Tribology, Laws of tribology e.g. Amontons law, Physical mechanical properties of surface layer, Geometrical properties of surfaces, parameters of surface study, Surface study with MEMS technology, Nature of surfaces and their contact. **11 Hrs**
2. **Friction and Wear:** Role of friction and laws of static friction, causes of friction, adhesion theory, Laws of rolling friction, Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, friction affecting wear, wear measurement, Wear of metals and non-metals. **14 Hrs**

Part-B

3. **Lubrication and Lubricants:** Introduction, dry friction, Boundary lubrication, classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses, properties of liquid and grease lubricants; lubricant additives , general properties and selection. **12 Hrs**
4. **Special Topics:** Selection of bearing and lubricant, Failure of bearing and its maintenance, diagnostic maintenance of tribological components, lubrication systems, Filters and filtration. **11 Hrs**

Text Books

1. B. Kumar, "Introduction to Tribology" , John Wiley and Sons Ltd , 2^{nd} Edition , 2013.
2. P. Sahoo , "Engineering Tribology", PHI Learning Pvt. Ltd. , 1^{st} Edition , 2005.
3. J. Halling , "Introduction to Tribology", Wykeham Publications Ltd, 1^{st} Edition, 1976.
4. A. Cameron, "Basic Lubrication Theory", Wiley (Indian Edition), 3^{rd} Edition, 1983.
5. G. E. Totten, "Handbook of lubrication and Tribology", Taylor and Francis Group , 2^{nd} Edition , 2006.

Reference Books:

1. Mang, Theo, Kirsten Bobzin, and Thorsten Bartels. Industrial tribology: Tribosystems, friction, wear and surface engineering, lubrication. John Wiley & Sons, 2011.
2. Donnet, Christophe, and Ali Erdemir, eds. Tribology of diamond-like carbon films: fundamentals and applications. Springer Science & Business Media, 2007.

Subject Code: PEME-207 **Subject Name: Theory of Plasticity**

Programme: B.Tech.	**L:** 4 **T: 0 P:** 0
Semester: 8th	**Teaching Hours:48** Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 30-40
External Marks: 60	**Duration of End Semester Exam (ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective VI

Prerequisites: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Apply knowledge of the theory of plasticity and flow rules.
2.	Analyze the generalization of the one-dimensional model to general states of stress and strain.
3.	Apply the load bounding theorem to plane strain problems.
4.	Design and model of a material undergoing permanent deformation upon loading.
5.	Evaluate various theories of failures.
6.	Apply the applications of slip line field theory.

Detailed Contents:

Part-A

1. **Introduction to Plasticity:** Introduction, Stress-Strain Behavior, Analysis of Stress, Mohr's Representation of Stress, Concepts of Stress Rate and Strain Rate, Idealized Stress-Strain Systems, Approximate Equation for Stress-Strain Curves (Ramberg-Osgood, Ludwig's And Karunes Equations), Bauschinger Effect-Yield Locus, Yield Surface. **11 Hrs**
2. **Foundations of Plasticity and Flow Rules:** The Criterion of Yielding, Strain-Hardening Postulates, The Rule of Plastic Flow, Particular Stress-Strain Relations, The Total Strain Theory, Theorems of Limit Analysis, Tresca Theory and Von-Mises Yield Criterion, Their Geometrical Representation, Experimental Evidence for the Criteria. **10 Hrs**
3. **Elastoplastic Bending and Torsion:** Plane Strain Compression and Bending, Cylindrical Bars Under Torsion and Tension, Thin-Walled Tubes Under Combined Loading, Pure Bending of Prismatic Beams, Bending of Beams Under Transverse Loads, Combined Bending and Twisting of Bars **8 Hrs**

Part-B

4. **Slip Line Field Theory:** Formulation of the Plane Strain Problem, Properties of Slip line Fields and Hodographs, Stress Discontinuities in Plane Strain, Construction of Slip Line Fields and Hodographs, Two-dimensional Plasticity, Hencjy's First Theorem, Geiringer's Velocity Equation, Applications of Slip Line Field Theory to Plane Strain Problems. **9 Hrs**
5. **Load Bounding:** The Lower Bound Theorem, The Upper Bound Theorem and Their Corollaries. Application of Load Bounding to Plane Strain Problems. **10 Hrs**

Text Books:

1. Chakrabarty, Jagabanduhu. Theory of plasticity. Elsevier, 2012.

2. Johanson and Miller, Plasticity for Mechanical Engineers, Van Nostrand.
3. Calladina, Engg Plasticity, Pergmean Press.
4. Kachanov, Lazar′ Markovich. Fundamentals of the Theory of Plasticity. Courier Corporation, 2004.
5. Goodier, James Norman, and P. G. Hodge Jr. Elasticity and Plasticity: The Mathematical Theory of Elasticity and The Mathematical Theory of Plasticity. Courier Dover Publications, 2016.

Reference Books:

1. Lubliner, Jacob. Plasticity Theory. Courier Corporation, 2008.
2. Hill, Rodney. The Mathematical Theory of Plasticity. Vol. 11. Oxford university press, 1998.

E-Books and online learning material:

1. Plastic Working of Metallic Materials by Prof. P.S. Robi

https://nptel.ac.in/courses/112/103/112103279/ Accessed on Nov. 21, 2021

2. Theory of Production Processes by Prof. (Dr.) Pradeep K. Jha

https://freevideolectures.com/course/4541/nptel-theory-production-processes/25

Accessed on Nov. 21, 2021.

Online Courses and Video Lectures:

1. https://www.digimat.in/nptel/courses/video/112107250/L11.html Accessed on Nov. 2021
2. http://www.nitttrc.edu.in/nptel/courses/video/112103279/L07.html Accessed on Nov. 2021

Subject Code: PEME-208 /PEME-316 Subject Name: Process Planning and Cost Estimation

Program: B.Tech.(ME**)**	**L:** 4 **T:** 0 **P:** 0
Semester: $7^{th}/8^{th}$	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Elective IV

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Classify the process, equipment and tools for various industrial products.
2	Analyze process planning activity chart.
3	Apply various quality techniques in process planning
4	Calculate cost estimation for different processes.
5	Create job order cost for different type of shop floor.
6	Calculate the machining time for various machining operations.

Detailed Contents:

Part-A

1. **Introduction to Process Planning:** Concept and objectives of process planning, process planning procedure, Approaches of Process Planning, Factors of Processes Selection: Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection. Relation of process planning with product manufacturing, production and project planning. **10 Hrs**
2. **Process Planning Activities:** Forecasting, Set of documents for process planning, Economics of process planning, Selection of cost optimal process, Quality standards and Quality assurance. Quality Control Techniques, Method Study, Time Study, Failure Mode and Effect Analysis, Ergonomics considerations, Relation of value engineering with process planning, Safety at work. **14Hrs**
3. **Introduction To Cost Estimation:** Importance of costing and estimation, methods of costing-elements of cost estimation, Types of estimates, Estimating procedure, Estimation labor cost, material cost, allocation of overhead charges, Calculation of depreciation cost. **08 Hrs**

Part-B

4. **Production Cost Estimation:** Concept of productivity, Estimation of Different Types of Jobs, Estimation of Forging Shop, Estimation of Welding Shop, and Estimation of Foundry Shop. **06Hrs**
5. **Machining Time Calculation:** Estimation of Machining Time, Importance of Machine Time Calculation, Calculation of Machining Time for Different Lathe Operations, Drilling and Boring, Machining Time Calculation for Milling, Shaping and Planning, Machining Time Calculation for Grinding. **10Hrs**

Text Books

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.
3. R. Kesavan, Vijaya Ramnath , “Process Planning and Cost Estimation”, New Age International Publishers.
4. Martin, Patrick, J-Y. Dantan, and Ali Siadat. "Cost estimation and conceptual process planning." digital enterprise technology. Springer, Boston, MA, 2007. 243-250.
5. Niazi, Adnan, et al. "Product cost estimation: Technique classification and methodology review." (2006): 563-575.

Reference Books:

1. Jung, Jong-Yun. "Manufacturing cost estimation for machined parts based on manufacturing features." Journal of intelligent manufacturing 13.4 (2002): 227-238.
2. Plebankiewicz, Edyta, Krzysztof Zima, and Mirosław Skibniewski. "Analysis of the first Polish BIM-Based cost estimation application." Procedia Engineering 123 (2015): 405-414.

Subject Code- PEME-210 **Subject Name: Finite Element Method**

Program: B.Tech.(ME)	**L: 4 T: 0 P: 0**
Semester: 7th /8th	**Teaching Hours: 48**
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/ Problems: 10-20**
External Marks: 60	**Duration of End Semester Exam(ESE): 3hr**
Total Marks: 100	**Course Status:** Elective III

On completion of the course, the student will have the ability to:

Sr. no.	Course Outcomes (CO)
1	Understand the procedure involved to solve a problem using Finite Element Methods.
2	Apply and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element.
3	Develop the element stiffness matrices using different approach
4	Apply suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
5	Analyze a 2D problem using line, triangular, axisymmetric and quadrilateral element.
6	Analyze a 3D problem using tetrahedral and hexahedral elements.

Detailed Contents:

Part-A

1. **Introduction:** General description of the method, Brief history of FEM, FEM v/s Classical Method, FEM v/s FDM, Brief explanation of FEA for a stress analysis problem. **03 Hrs**
2. **Vectors, Matrices, and Tensors:** Introduction to matrices, Vector spaces, Definition of tensors, the symmetric Eigen problem, Matrix displacement equations, Solution of matrix displacement equations. **04 Hrs**
3. **Basic Equations in Elasticity:** Introduction, Stresses in a typical element, Equations of equilibrium, strains, strain displacement equations, linear constitutive law. **05 Hrs**
4. **Nomenclature of Finite Elements:** Element shapes, nodes, nodal unknowns, Coordinate systems. **03 Hrs**
5. **Shape Functions:** Introduction, Polynomial shape functions, Convergence requirements of shape functions, derivation of shape functions using polynomials, finding shape functions using lagrange polynomials. **06 Hrs**

Part-B

6. **Strain Displacement Matrix and Assembling Stiffness Equation :** Strain displacement matrix for bar and CST element, Strain displacement relation for beam element, Assembling stiffness equation by direct approach, galerkin's method, virtual work method and variational method. **09 Hrs**
7. **Discritization of a Structure:** Nodes as discontinuities, Refining mesh, Use of symmetry, Finite representation of infinite bodies, Element aspect ratio, Higher order element v/s Mesh refinement. **03 Hrs**

8. **Finite Element Analysis – Bars, Trusses, Beams and Shells :** Tension bars/columns, Two dimensional trusses, plane stress and plane strain problems, beam analysis using two noded elements, Force on shell element, shell analysis. **10 Hrs**
9. **Isoparametric Formulation :** Introduction, Coordinate transformation, Basic theorems of iso parametric concept, Uniqueness of mapping, Iso parametric, Super parametric and Sub parametric Elements, Assembling stiffness matrix, Numerical integration. **05 Hrs**

Text Books:

1. D. L. Logan, "A First Course in the Finite Element Method", CL Engineering ,6th Edition, 2017,
2. Klaus-Jurgen Bathe, "Finite Element Procedures in Engineering Analysis", Prentice Hall, 2nd Edition, 2014.
3. T. R. Chandrupatla , Ashok D. Belegundu, "Introduction to Finite Element in Engineering", Pearson Publications, 4th Edition 2012.
4. D. D. Hutton, "Fundamental of finite element analysis", McGraw Hill Publications, 1st Edition, 2003.
5. R. D. Cook, D. D. Malkus, M. E. Plesha and R. J. Witt, "Concepts and Applications of Finite Element Analysis", John Wiley Publications, 4th Edition. 2002

Reference Books:

1. Zienkiewicz, Olgierd Cecil, et al. The finite element method. Vol. 3. London: McGraw-hill, 1977.
2. Bathe, Klaus-Jürgen. "Finite element method." Wiley encyclopedia of computer science and engineering (2007): 1-12.

Subject Code: PEME-211 **Subject Name: Modeling and Simulation**

Programme: B.Tech.	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 30-40
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective V

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Apply techniques of modeling in the context of hierarchy of knowledge about a system.
2.	Create the physical modeling of system and modeling of system with known structure.
3.	Apply the optimization techniques effectively.
4.	Apply the neural modeling to various systems.
5.	Apply different types of simulation techniques.
6.	Design the models for the purpose of optimum control.

Detailed Contents:

Part-A

1. **Introduction**: System environment, input and output variables, State variables; Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy. **6Hrs**

2. **Physical Modeling:** Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models. **6Hrs**
3. **Modeling of System with Known Structure:** Review of conservation laws and the governing equation for heat, mass and momentum transfer, Deterministic model-(a) distributed parameter models in terms of partial identification and their solutions and (b) lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modeling for control. **8Hrs**
4. **Optimizations and Design of Systems:** Summary of gradient based techniques: Nontraditional Optimizations techniques (1) Genetic Algorithm (GA) - coding, GA operations, Application (2) Simulated Annealing **7Hrs**

Part-B

5. **Neural Network Modeling of Systems only with Input-output Database:** Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm, Application to complex engineering systems and strategy for optimum output. **7Hrs**
6. **Modeling Based on Expert Knowledge:** Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers. **6Hrs**
7. **Simulation of Engineering Systems:** Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems. **8Hrs**

Text Books:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press 2000
2. Ogata K " Modern control Engineering" 3 rd edition. Prentice hall of India 2001.
3. Jang J.S.R. sun C.T and Mizutani E,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prentice hall of India 2002.
4. Shannon, R. E., "System Simulation: the Art and Science", Prentice Hall Inc. 1990.
5. Pratab.R " Getting started with MATLAB" Oxford university Press 2009

Reference Books:

1. B OuldBouamama , J Thoma , Jean U Thom, Modelling and Simulation in Thermal and Chemical Engineering: A Bond Graph Approach, Springer, New York (2000).
2. Dean Karnopp, Vehicle Dynamics, Stability, and Control, CRC Press, (2013).

Subject Code: PEME-212 **Subject Name: Optimization Techniques**

Programme: B.Tech. ME	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours: 48** Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems: 70-80**
External Marks: 60	**Duration of End Semester Exam (ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective V

Prerequisites: NIL

Additional Material Allowed in ESE: NIL

On completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Understand the characteristics of different types of operations research and optimization models in real-life environments.
2.	Application of different types of deterministic and probabilistic models in finding real-life environments.
3.	Design new simple models, like CPM, to improve decision making.
4.	Apply the various OR tools for better decision making.
5.	Identify and apply the appropriate operation research model.
6.	Apply the replacement and network models in real problems.

Detailed Contents:

Part-A

1. **Introduction:** Introduction to Optimization and operation research, Engineering application, origin, Statement of an Optimization problem and its role in solving industrial problems, Optimal Problem formulation, Classification of Optimization problem or mathematical models, Classification of mathematical models: various decision-making environments. **7 Hrs**
2. **Linear Programming:** Formulation of linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Big M method and two-phase method, Introduction to duality theory and sensitivity analysis. **6 Hrs**
3. **Transportation and Assignment Models:** Various initial basic feasible solutions methods, Optimization of transportation and assignment using different methods considering the concept of time and cost function. **7 Hrs**
4. **Dynamic Programming:** Introduction to deterministic and probabilistic dynamic programming. **6Hrs**

Part-B

5. **Queuing Theory:** Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations. **6 Hrs**
6. **Replacement Models:** Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy. **8 Hrs**

7. **Network models:** Shortest route and traveling sales - man problems, PERT &CPM introduction, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction. **8 Hrs**

Text Books:

1. P. K., Gupta and D. S., Hira, *Operations Research*, S. Chand Limited, India, 2008.
2. D. M., Miller, and J. W., Schmidt, *Industrial Engineering and Operations Research*, John Wiley & Sons, Singapore, 1990.
3. H. A., Taha, *Operations Research*, Pearson, 2004.
4. R., Paneerselvam, *Operations Research,* Prentice Hall of India, New Delhi, 2008.
5. G., Srinivasan, *Operations Research-Principles and Applications*, PHI Pvt. Ltd., 2010.

Reference Books:

1. P., Ramamurthy, *Operations Research*, New Age International (P) Limited, 2007.
2. R., Pannerselvam, *Design and Analysis of Algorithms*, Prentice Hall of India, New Delhi, 2007.

E-Books and Online Learning Material

1. Operations Research - A Model-Based Approach by H. A. Eiselt, Carl-Louis Sandblom, Springer Texts in Business and Economics https://www.kobo.com/us/en/ebook/operations-research Accessed in June 2021
2. Introduction to Operations Research- Deterministic Models by Juraj Stacho https://www.cs.toronto.edu/~stacho/public/IEOR4004-notes1.pdf Accessed in June 2021

Online Courses and Video Lectures

1. https://nptel.ac.in/courses/112/106/112106134/ Accessed in June 2021
2. https://nptel.ac.in/courses/112/106/112106131/ Accessed in June 2021
3. https://nptel.ac.in/courses/110/106/110106059/ Accessed in June 2021

Topics for Self-Learning

1. Two-phase method.
2. Degeneracy in linear programming problems.
3. Dual simplex method and Revised simplex method.
4. Dual transportation problem, Traveling salesman problem.
5. System reliability.

Subject Code: PEME-214 **Subject Name: Microprocessors in Automation**

Programme: B.Tech.	**L: 4 T: 0 P:** 0
Semester: 6th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems: 1**0-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective II

Prerequisites: Nil

Additional Material Allowed in ESE: Scientific Calculator

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Understand the concept of automation.
2.	Design the pneumatic and hydraulic system for a given application in automation.
3.	Describe the architecture, features and functioning of microprocessor
4.	Understand the concepts of different parameters included in 8085 processor.
5.	Apply the knowledge of instruction set for performing various operations on microprocessor.
6.	Select microprocessor for a particular application.

Detailed Contents:

Part-A

1. **Introduction to Automation:** Concept and scope of automation, Socio-economic impacts of automation, Types of Automation, Low Cost Automation. **7Hrs**
2. **Technologies:** Mechanical, Electrical, Hydraulic, Pneumatic, Hybrid systems, Comparative evaluation. Development of small automation systems using mechanical devices. Direct and Indirect Control of Single/Double Acting Cylinders, Designing of logic circuits for a given time displacement diagram & sequence of operations, Basic circuit design problems. **10Hrs**
3. **Microprocessors:** Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data address and control bus), Microprocessor systems with bus organization. **10Hrs**

Part-B

4. **Architecture of a Microprocessor – 8085:** Concept of bus and bus organization, Functional block diagram and function of each block, Pin details of 8085 and related signals, Demultiplexing of address/data bus and memory read/write cycles. 9**Hrs**
5. **Instruction Set for Intel 8085:** Instruction and data format – opcode and operand and its word size, Instruction cycle, machine cycle, T-states, fetch cycle, and execute cycle, Different addressing modes, Status flags and their importance, Data transfer, arithmetic and logical operation, branding and machine control instructions, Use of stacks and subroutines, Assembly language programming. **12Hrs**

Text Books:

1. S.R. Majumdar, "Pneumatic Control", 4th Edition, Tata McGraw Hill, 2004.
2. M.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 5th Edition, Pearson Education, 2009.

3. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 5th Edition, Penram International Publishing, New Delhi, 2007.
4. Ray, A.K. & Burchandi, K.M., "Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing", 3rd Edition, Tata Mc. Graw Hill, 2015.
5. K. L. Short, "Microprocessors and Programmed Logic", 2nd Edition, Pearson Education, 2008

Reference Books:

1. Brian Morriss, "Automated Manufacturing Systems – Actuators, Controls, 1st Edition, Sensors and Robotics", McGraw Hill, 2000
2. D.V. Hall, "Microprocessor and Interfacing-Programming and Hardware", 2nd Edition, Tata McGraw-Hill Publishing Company Limited, 2008

Subject Code: PEME-215 **Subject Name: Design of Transmission Systems**

Programme: B.Tech. (ME**)**	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design Problems: 80**-90
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Subject Status: Elective III**

Prerequisites: Nil.

Additional Material Allowed in ESE: Nil

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Design flexible elements like belt, ropes and chain drives for engineering applications.
2	Design of spur and helical gear drives for power transmission.
3	Design bevel and worm drives for power transmission.
4	Design multi speed gear box for machine tool and automotive applications.
5	Design clutch and brake systems for engineering applications.
6	Design and analyze the whole transmission system.

Detailed Contents:

Part-A

1. **Design of flexible elements** - Belt materials ,Working stresses in belts, Belt Speed, Belt Joints, Slip of the belt, Creep of belt, Ratio of driving tensions, Centrifugal Tension, Design of Flat belts and pulleys, Design of V belts and sheaves, Selection of wire ropes, Design of Transmission Chains and Sprocket. **10Hrs**
2. **Spur and Helical gears** - Gear materials, Tooth terminology, Design of spur & helical gears, Beam Strength of gear teeth- Lewis Equation, number of teeth, Dynamic Tooth Load, Static Tooth Load, Wear Tooth Load, Equivalent number of teeth. **12Hrs**
3. **Bevel and Worm gears**- Bevel gear: Gear materials, Tooth terminology, Design of Bevel Gear, equivalent number of teeth. Worm Gear: Gear materials, Tooth terminology, Design of Worm and Worm Wheel, Thermal rating of worm gearing, Efficiency of worm gearing. **8Hrs**

Part-B

4. **Gear boxes**- Need, Design of sliding and constant mesh gear boxes, Speed selection, Determination of number of teeth. Design of multi speed gear box for machine tool applications, Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications, Continuous variable transmission system. **10Hrs**
5. **Clutches and Brakes**- Design of single and multi-plate clutches, cone clutch. Design of brakes: Materials for brake lining, Band brakes, Band and block brakes, Differential band brakes, Internal expanding shoe brakes. **8Hrs**

Text Books:

1. Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., "Mechanical Engineering Design", 10thEdition, Tata McGraw-Hill, 2014.

2. Sen and Bhattacharya, “Principles of Machine Tools”, New Central Book Agencies, 1975.
3. Khurmi R.S. and Gupta J.K.,”Machine Design”, S. Chand Publishing Co., 1st Multicolor edition , 2014
4. Sharma P.C. and Aggarwal D.K., “Machine Design”, S.K.Kataria & Sons, 2013
5. Design Data Handbook for Mechanical Engineers, Mahadevan, K. and Reddy Balveera, K., CBS Publishers and Distributors Pvt. Ltd., 4th Edition, 2013.

Reference books:

1. Bhandari V.B., “Design of Machine Elements”, 15th Reprint, Tata McGraw-Hill Book Co, 2014
2. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2003

E-Books and online learning material

1. Design of Transmission Systems Accessed on August, 2021
   https://nptel.ac.in/courses/112/105/112105234/
2. Design of Transmission Systems Accessed on August, 2021
   https://nptel.ac.in/courses/112/105/112105124/

Subject Code: PEME-302 **Subject Name: Modern Welding & Forming Processes**

Programme: B.Tech.	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective IV

Prerequisites:

Additional Material Allowed in ESE: NIL

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Apply suitable welding process and technique to join a given material.
2.	Analyze the distortion and residual stresses induced in weldments.
3.	Design for both static and fatigue loading conditions.
4.	Apply suitable welding automation for the production of engineering components.
5.	Understanding of metal forming process.
6.	Formulate relevant research problems, conduct experimental and/or analytical work and analyze results using modern mathematical and scientific methods.

Detailed Contents:

Part-A

1. **Introduction to Modern Welding & Forming Processes:** Physics of welding arc, heat flow in welding, theory of heat flow, cooling rate determination, selection of welding parameters based of heat flow analysis, residual stress and distortion, joint design, analysis of fracture and fatigue of welded joints. Conventional processes, Explosive forming, electro hydraulic forming, magnetic pulse forming, Principles and process parameters- Advantages -Limitations and Applications. **8 Hrs**
2. **Special Welding Processes:** Electron beam welding, laser beam welding, ultrasonic welding, explosion welding, electro slag and electro gas welding, cold pressure welding, Friction Stir welding, diffusion bonding and adhesive bonding. **6Hrs**
3. **Heat Effects Of Welding:** Metallurgical effects of heat flow in welding-TTT curve-continuous cooling transformation diagrams development of residual stress, methods of relieving or controlling welding residual stresses, types and control of distortion, pre-heat and post welding heat treatment. **8Hrs**
4. **Weldability Of Ferrous And Non-Ferrous Alloys:** Weldability of carbon and alloy steels, stainless steels, cast irons, copper and its alloys, aluminum and its alloys, titanium and its alloys, Ni and its alloys, weldability tests. **6 Hrs**

Part-B

5. **Welding Design:** Typical joints for different welding processes, principles of welding joint design and location of joint within the member, evolving good weld design, welding symbol-Blue print reading, welding design for static and fatigue loading, fracture toughness. **6 Hrs**
6. **Plastic Forming of Metals-Rolling:** Plastic Forming of Metals-Rolling and Extrusion: Rolling and Extrusion, classification, rolling mills, rolling of bars & shapes, rolling forces, analysis of rolling, defects in rolling, theories of hot & cold rolling, torque power estimation. Extrusion: classification, equipment, deformation lubrication and defects, analysis, hydrostatic extrusion, tube extrusion.**8Hrs**
7. **Recovery Systems:** Drawing & Sheet Metal Forming, rod & wire drawing equipment, analysis, deep drawing, tube drawing, analysis, residual stresses, sheet metal forming, methods, shearing and blanking,

bending, stretch forming, deep drawing, forming limit criteria, defects, press brake forming, explosive forming. **6 Hrs**

Text Books:

1. Kalpakjian and Schmid, Manufacturing Processes for Engineering Materials, Prentice Hall. 5th edition, 2017
2. Ghosh and Mallick,Manufacturing Science, East-West Press Private Limited.
3. George E Dieter, Mechanical Metallurgy, Tata McGraw Hill, 3rd Edition
4. Degarmo, J. T. Black,Materials and Processes in Manufacturing, PHI, Pvt Ltd.
5. M. P. Groover.Fundamentals of modern manufacturing processes, wiley publisher

Reference Books:

1. Boljanovic, Vukota. Sheet metal forming processes and die design. Industrial Press Inc., 2004.
2. Messler Jr, Robert W. Principles of welding: processes, physics, chemistry, and metallurgy. John Wiley & Sons, 2008.

Subject Code- PEME-304 **Subject Name: Computer Aided Process Planning**

Program: B.Tech.(ME**)**	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Course Status:** Elective VI

On completion of the course, the student will have the ability to:

Sr no	Course Outcomes (CO)
1	Understand and explain the difference between traditional and computer aided process planning.
2	Apply group technology concepts.
3	Analyze the effect of experience on various design approaches.
4	Elaborate production systems at operation and plant level.
5	Explain different aspects of automated process planning.
6	Consideration of different production families for integrated planning.

Detailed Contents:

Part-A

1. **Introduction:** The Place of Process Planning in the Manufacturing cycle-Process planning and production Planning-Process planning and Concurrent Engineering, CAPP, Group Technology. **10 Hrs**
2. **Part Design Representation:** Design Drafting- Dimensioning- Conventional Tolerance-Geometric Tolerance-CAD-input/output devices- Topology - Geometric transformation-Perspective transformation-Data Structure-Geometric modeling for process planning - GT Coding-The OPITZ system-The MICLASS System. **09 Hrs**
3. **Process Engineering and Process Planning:** Experience based planning-Decision table and Decision trees-Process capability analysis-Process planning-Variant process planning-Generative approach-Forward and backward planning, Input format, AI. **10 Hrs**

Part-B

4. **Computer Aided Process Planning Systems:** Logical Design of process planning-Implementation considerations-Manufacturing system components, Production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP. **10 Hrs**
5. **An Integrated Process Planning Systems:** Totally integrated process planning systems-An Overview-Modulus structure-Data Structure-Operation-Report Generation, Expert process planning. **09 Hrs**

Text Books:

1. G. Halevi , R. D. Weill, "Principle of process planning- A Logical Approach", Chapman & Hall, 1st Edition , 1995

2. T. C. Chang , Richard A.Wysk, "An Introduction to automated process planning systems", Prentice Hall 3rd Re-Print , 1985
3. T.C. Chang, "An Expert Process Planning System", Prentice Hall, 1985.
4. N. Singh, "Systems Approach to Computer Intergrated Design and Manufacturing", John Wiley &Sons,2nd Edition , 1996
5. P.N. Rao, N Tewari , T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Co., 3rd Re-print, 2000.

Reference Books:

1. Alain Delchambre, "Computer-aided assembly planning", Springer Science & Business Media, 2012.
2. Puigjaner, Luis, and Georges Heyen, eds. "Computer Aided Process and Product Engineering (CAPE)", John Wiley & Sons, 2007.

Subject Code: PEME-305 **Subject Name: Machining Science**

Programme: B.Tech. (ME**)**	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Subject Status:** Elective III

Prerequisites: NIL.

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Elaborate the conceptual significance of conventional material removal in manufacturing.
2	Apply basic principles of science to correlate the input parameters of conventional machining processes with output parameters like cutting forces, power, tool life etc.
3	Solve problems and derive theoretical relations related to mechanics of metal machining.
4	Develop procedure for experimental determination of cutting force, temperature and tool life by using suitable equipment.
5	Analyze and optimize machining processes.
6	Suggest remedial measures to reduce the harmful ecological impact of machining processes.

Detailed Contents:

Part-A

1. **Introduction to Machining Processes:** Concept of conventional material removal; Classification and applications of machining processes in modern manufacturing practices; Surface generation with machining; Orthogonal and oblique cutting; Tool geometry of conventional cutting tools. **07 Hrs**
2. **Mechanics of Machining:** Mechanism of chip formation process; Type of chips; Chip contraction coefficient; Machining parameters; Cutting force and power requirement in single point turning process; Velocity ratios; Merchant's theory; Shear angle relationships; Specific cutting pressure. **09 Hrs**
3. **Tool Wear and Tool Life:** Mechanism of wear; Type of wear in reference to cutting tools; Criteria of tool wear; Measurement of tool wear; Tool life: definition & factors affecting tool life; Taylor's tool life equation; Applications of tool life equation. **06 Hrs**
4. **Machinability:** Concept of machinability; Assessment of machinability; Role of various factor on machinability; Estimation of machining time in turning, drilling, milling and broaching operations; Major factor affecting machining time; Methods of calculating machining time in turning, drilling and milling operations; Process capabilities of different machining processes. **07 Hrs**

Part-B

5. **Measurement of Cutting Forces:** Basic principles and need for measurement of cutting forces; Introduction to tool dynamometers for turning, drilling and milling operations. **05 Hrs**
6. **Thermal Aspects of Machining:** Friction and shear stress distribution in metal cutting; Kinetic coefficient of friction; Stagnant phenomena; Average shear plane temperature;

Average chip-tool interface temperature; Experimental determination of cutting temperature. **07 Hrs**

7. **Economy and Ecological Aspect of Machining:** Machining costs; Determination of optimum cutting speed for minimum cost; Maximum production rate and profit rate; Metal cutting fluids, their characteristics & applications; Harmful ecological and health effects of metal cutting fluids; Economical use of metal working fluids. **07 Hrs**

Text Books

1. Winston A. Knight, Geoffery Broothroyd, *"Fundamentals of Metal Machining & Machine Tools"*, CRC Taylor & Francis, 2005.
2. Serope Kalpankjian, Steven R. Sachimid, *"Manufacturing Engineering and Technology"*, Pearson Education, 2001
3. G.K. Lal, *"Introduction to Machining Science"*, New Age International Ltd., 2007
4. B.L. Juneja, G.S.Sekhon, *"Fundamentals of Metal Cutting and Machine Tools"*, New Age International Ltd., 2003.
5. A. Bhattacharya, *"Metal Cutting Principles"*, CBS Publishers, 1989.

Topics for Self Learning (TSL)

1. Systems of tool nomenclature
2. Advanced materials for cutting tools
3. Standards for tool wear measurements
4. Minimum quantity lubrication

Subject Code: PEME-306 **Subject Name: Rapid Prototying**

Programme:B.Tech. (ME)	**L:** 4 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Subject Status:** Elective III

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#.	Course Outcomes (Cos)
1	Understand the concept of Rapid prototyping and its importance in today's industry
2	Classify various rapid prototyping techniques based upon their principles and processes.
3	Describe different errors in rapid prototyping to improve the overall working of manufacturing.
4	Discuss various case studies of rapid prototyping in different fields of manufacturing.
5	Illustrate implementation of rapid prototyping in biomedical field.
6	A various technologies related to Rapid prototyping in medical field

Detailed Contents:

Part-A

1. **Introduction:** Introduction to Prototyping, history of RP systems, Growth of RP industry, Traditional Prototyping Vs. Rapid Prototyping (RP), Fundamentals of rapid prototyping, Advantages and limitations of rapid prototyping, Classification of Rapid Manufacturing Processes: Additive, Subtractive, Formative, Generic RP process. **8Hrs**
2. **CAD Modeling and Data Processing for RP:** Fundamental Automated Processes, Process Chain, 3D Modeling, Data Conversion and Transmission, Checking and Preparing, Building, Postprocessing, supported file formats for RP (STL, IGES, HP/GL, CT, STEP) **8Hrs**
3. **Errors in RP processes:** Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS. **4Hrs**

Part-B

4. **RP Processes:** Introduction, Principle, Process, Applications, Mateirals, Advantages and Disadvantages of various RP systems: StereoLithography (STL), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Selective laser Sintering (SLS) Process, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), 3D Printing (3DP). **15Hrs**
5. **Case Studies:** Discussion of case studies for various RP manufacturing technologies. **8Hrs**
6. **Biomedical Applications:** Bronchial Stunting, Cranial Implants, Spinal guides, Pedicle screws. **5Hrs**

Text Books:

1. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.
2. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.

3. Connell, John, and Linda I. Shafer. Object-oriented rapid prototyping. Yourdon Press, 1995.
4. Hoque, Md Enamul, ed. Advanced applications of rapid prototyping technology in modern engineering. BoD–Books on Demand, 2011.
5. Hoque, Md Enamul, ed. Rapid prototyping technology: principles and functional requirements. BoD–Books on Demand, 2011.

Reference Books:

1. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons
2. Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer,

Subject Code- PEME-307 **Subject Name: Characterization of Materials**

Program: B.Tech.(ME)	**L: 4 T: 0 P: 0**
Semester: 7th /8th	**Teaching Hours: 48**
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 10%**
External Marks: 60	**Duration of End Semester Exam(ESE): 3hr**
Total Marks: 100	**Course Status: Elective IV**

On completion of the course, the student will have the ability to:

Sr no	Course Outcomes (CO)
1	Understand and use basic concepts of testing the material and their study.
2	Apply various techniques to study the internal structure of the material.
3	Recognize the spectroscopic behaviour of the material under various conditions of material development.
4	Evaluate and analyze the performance of material under the effect of temperature cycles.
5	Conclude upon the method of development by studying the behavior of the material under various conditions.
6	Analyze the dynamic behaviors of the material.

Detailed Contents:

Part-A

1. **Introduction:** Introduction to mechanical testing, strength, fatigue, creep, fracture toughness, hardness, Introduction to characterization; importance and its applications. **10Hrs**
2. **Microscopic and Diffraction techniques:** Scanning electron microscopy (SEM) and transmission electron microscopy (TEM), Atomic force microscopy (AFM), Scanning Probe Electrochemistry (SPE), X-ray (XRD) **12 Hrs**

Part-A

3. **Spectroscopic techniques:** Infrared Spectroscopy (IR), Ultraviolet (UV-visible), Fourier Transform Infrared Spectroscopy (FTIR), Raman spectroscopy, Electron Spin Resonance (ESR) **14 Hrs**
4. **Thermal analysis techniques:** Thermo-gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Thermo-Mechanical Analysis (TMA) and Dynamic Mechanical Analysis (DMA). **12 Hrs**

Text Books:

1. Zhang, Sam; Li, Lin; Kumar, Ashok. "Materials characterization techniques". CRC Press, 2008
2. Leng, Yang. "Materials characterization: introduction to microscopic and spectroscopic methods" Singapore: John Wiley & Sons, cop. 2008
3. D. Briggs, M.P. Seah, "Practical Surface Analysis by Auger and X-Ray Photoelectron Spectroscopy" (Wiley, Chichester, 1990)

4. P. R. Khangaonkar, "An Introduction to Material Characterization", Penram Intl. Publishing (India) Pvt. Ltd.-Mumbai; First Edition, 2008.
5. Nicholas P. Cheremisinoff. "Polymer Characterization- Laboratory Techniques and Analysis", Elsevier, William Andrew 1996

Reference Books:

1. E. N. Kauffmann, "Characterization of Materials", 2 Volume Set, Wiley-Blackwell, 2003
2. R. F. Egerton, "Physical Principles of Electron Microscopy", Springer US, 2005

Subject Code- PEME-308 **Subject Name: Surface Science**

Program: B.Tech.(ME)	**L: 4 T: 0 P: 0**
Semester: 6th	**Teaching Hours: 48**
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 10%**
External Marks: 60	**Duration of End Semester Exam(ESE): 3hr**
Total Marks: 100	**Course Status: Elective II**

On completion of the course, the student will have the ability to:

Sr no	Course Outcomes (CO)
1	Understand the concept of surfaces and their structure.
2	Apply different technologies to read the surface.
3	Analyze the effect of adsorption and desorption.
4	Elaborate different modes of growth in the solids.
5	Evaluate the structural defects at the surfaces.
6	Understand and apply different laws and methods to study the surface diffusion.

Detailed Contents:

Part-A

1. **Introduction:** Why Surfaces? Peculiarities of surfaces; Importance of surfaces; Two-Dimensional Lattices; Miller Indices. **12 Hrs**
2. **Experimental Probes and Techniques:** Ultrahigh Vacuum**;** Low Energy Electron Diffraction; Transmission Electron Diffraction; Electron Spectroscopy Method; Infrared Spectroscopy; Transmission Electron Microscopy; Scanning Electron Microscopy; Atomic Force Microscopy. **12Hrs**

Part-B

3. **Kinetics of Adsorption/Desorption and Growth Modes:** Adsorption Kinetics; Thermal Desorption; Adsorption Isotherms; Non-Thermal Desorption; Surface Energy; Growth Modes. **12 Hrs**
4. **Defects and Surface Diffusion:** Point Defects; Steps, Singular and Vicinal Surfaces, Facets; Random-Walk Motion; Fick's Laws; Tracer and Chemical Diffusion; Intrinsic and Mass Transfer Diffusion; Surface Diffusion and Phase Formation. **12 Hrs**

Text Books:

1. Oura, Kenjiro, V. G. Lifshits, A. A. Saranin, A. V. Zotov, and M. Katayama. *Surface science: an introduction*. Springer Science & Business Media, 2013.
2. Hudson, John B. *Surface science: an introduction*. John Wiley & Sons, 1998.
3. Wandelt, Klaus, ed. *Surface and Interface Science, Volumes 1*. Concepts and Methods, Wiley-VCH Verlag & Co. KGaA, 2012.
4. Kolasinski, Kurt W. *Surface science: foundations of catalysis and nanoscience*. John Wiley & Sons, 2012.
5. Woodruff, David Phillip. *Modern techniques of surface science*. Cambridge university press, 2016.

Reference Books:

1. Gast, Alice P., and Arthur W. Adamson. *Physical chemistry of surfaces*. New York: Wiley, 1997.
2. Bracco, Gianangelo, and Bodil Holst, eds. *Surface science techniques*. Springer Science & Business Media, 2013.

Subject Code: PEME-309 **Subject Name: Modern Casting Processes**

Programme: B.Tech(ME)	**L**: 4 **T**: 0 **P**: 0
Semester: 8th	**Teaching Hours**: 48
Theory/Practical: Theory	**Credits**: 4
Internal marks: 40	**Percentage of Numerical/Design Problems**: 10-20
External marks: 60	**Duration of End Semester Exam**: 3hrs
Total Marks: 100	**Course Status**: Elective V

Prerequisites: NA

Additional Material Allowed in ESE: NIL

On Completion of this course, students will have the ability to:

CO#	Course Outcomes
1	Understand and apply the principles of metal casting processes and develop analytical relation between input and output process parameters.
2	Analyze and apply the concept of cooling rate of materials in metal casting.
3	Apply theoretical and experimental techniques for measurement of important outcomes of casting processes like hardness, dimensional accuracy etc.
4	Design the model of casting economics and optimization and its measurement.
5	Apply the fundamentals of physics to develop theoretical relations for different types of casting processes.
6	Analyze and design the Mechanization in Foundries for different processes.

Detailed Contents:-

Part-A

1. **Trends & scope in foundry Industry**: Position of foundry industry worldwide and in India, analysis of data in respect of production and demand, recent trends in quality specifications like dimensional accuracy, surface finish and property requirements, specifications, properties and applications of modern cast alloys- SG iron. Al – alloys, Mo- alloys, Ti – alloys. **6 Hrs**
2. **Design considerations in manufacturing of patterns and dies**: Computer Aided pattern design and manufacture, pattern making machines and equipments, Computer aided design of dies in die casting and centrifugal casting, materials used and allowances in patterns and die. **6Hrs**
3. **Design of gating system**: Elements and types of gating systems, , Risers – types and functions of risers, directional solidification – factor affecting, Nucleation kinetics, fundamentals of growth, solidification of single-phase alloys and significance, use of exothermic sleeves, bricks, chills and their types, types and uses of filters, computer aided design for gating and risering systems. **7Hrs**

Part-B

4. **Modern molding and core making processes and equipments**: Various types of sands used for molding and core making, testing of sand, high pressure line molding, Dissamatic, chemically bonded sands; shell molding binder, hardener and type of sand used in shell molding, procedure used for making shell sand, plants used, properties and tests on shell sand, stick point strength, advantages and applications; Resin bonded sands, alkyl resins, phenolic resins and furnace sands, cold box method of core making – advantages and applications, ceramic molding, vacuum molding. **12 Hrs**

5. **Special Casting processes**: Investments casting processes and applications; Continuous casting, principle, processes and applications; Die casting, low pressure / gravity, pressure and squeeze, advantages, limitations and applications, centrifugal casting, calculations of various parameters in centrifugal casting, die temperature, rotational speeds, advantages, limitations and applications of centrifugal casting, defects in centrifugal casting. **10 Hrs**
6. **Mechanization in Foundries**: Conveying systems – sand bins, belt conveyors, roller conveyors, bucket elevators; Pouring systems – monorail, auto pour systems; sand plants, practical aspects, layout and mechanization. **7 Hrs**

Text Books:

1. Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
2. Principles of Foundry Technology - P.L. Jain (TMH)
3. Advanced Pattern Making – Cox I.I. (The Technical Press, London.)
4. Metal Castings – Principles & Practice - T.V. Ramana Rao. (New Age International Pvt. Ltd. Publishers.)
5. Foundry Engineering – Taylor, Fleming & Wulff (John Wiley)

Reference Books:

1. Mechanization of Foundry Shops – Machine Construction - P.N. Aeksenov (MIR)
2. Fundamentals of Metal Casting Technology - P.C. Mukherjee (Oxford, IBH)

Subject Code: PEME-310 **Subject Name: Micromaching Technologies**

Programme: B.Tech.	**L:** 4 **T:** 0 **P:** 0
Semester: 7^{th} /8^{th}	**Teaching Hours:** 48Hours
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective III

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Explain role of computers and information technology in Micromaching Technologies.
2.	Demonstrate the capability of selecting suitable manufacturing processes to manufacture the products optimal.
3.	Apply the techniques, skills and tools such as CIM, CAPP, CAI,CMM.
4.	Design micro systems and know different micro fabrication system.
5.	Understand the properties and microstructure of materials.
6.	Understand principle of microsystems and feed back systems.

Detailed Contents:

Part-A

1. **Introduction:** Common engineering materials and their important mechanical and manufacturing properties. General classification of manufacturing processes, Importance of manufacturing processes, economics and selection of manufacturing processes. Introduction to Micro System design. **3Hrs**

2. **Machining Processes:** Principles of metal cutting, cutting tool materials and applications, types of single point cutting tools. Geometry of single point cutting tool. Cutting fluids and their functions, types of cutting fluids, selection of cutting fluids. **6Hrs**
3. **Micromechanics:** Micro fabrication technologies, Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials. **11Hrs**

Part-B

4. **Basic Micro-Fabrication:** Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes – Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining. Electron beam machining. **10Hrs**
5. **Recent Trends:** Computer Aided Process Planning (CAPP) - concept, types, features, methods and importance. Computer Integrated Manufacturing (CIM): need, block diagram, functional areas covered and their importance. Protocols in CIM- their features, functions and applications. Computer Aided Inspection (CAI) - concept, benefit, types, working and examples. Coordinate Measuring Machine (CMM) - its working and applications. Artificial

intelligence- concept, definition and application areas, neural network: working principles, applications and limitations. Lean manufacturing - concept, sources of waste, benefits and applications. Factory of future (FOF). **10Hrs**

6. **Advanced Technologies:** Role of control system in instrumentation. Structural behavior, sensing methods, micro scale transport – feedback systems. Rapid Prototyping (RP): working principles, methods, applications and limitations, rapid tooling, techniques for rapid prototyping. **8Hrs**

Text Books:

1. P. Radhakrishnan & S. Subranarayan, CAD/CAM/CIM , New Age Intentional
2. Bedworth, Wolfe and Anderson Computer Integrated Design & Manufacturing, McGraw Hill International Publication.
3. Sami Franssila, "Introduction to Micro Fabrication", John Wiley and sons Ltd., UK, 2004, ISBN: 978-0-470-85106-7.
4. Peter Van Zant, "Microchip fabrication", McGraw Hill, 2004
5. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, 2006

REFERENCES Books:

1. Madore J, "Fundamental of Micro Fabrication", CRC Press, 2002
2. Mark J. Jackson, "Microfabrication and Nanomanufacturing", CRC Press, 2006

Subject Code: PEME-311 **Subject Name: Manufacturing Systems**

Programme: B.Tech.	**L:** 4 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 46 Hours
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective VI

Prerequisites: Nil

Additional Material Allowed in ESE: NIL

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Analyze role of computers and information technology in manufacturing systems.
2.	Design control system in instrumentation and manufacturing.
3.	Apply the techniques, skills and tools such as CIM, CAPP, CAI, and CMM.
4.	Evaluate the use of robotics, and recent advances in the field of manufacturing.
5.	Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per their attributes.
6.	Apply the Applications of rapid prototyping for real world.

Detailed Contents:

Part-A

1. **Introduction:** Evolution of transformation & manufacturing systems. Need of attitude, knowledge & skill required for application of manufacturing systems. Need for system approach. Role of computers and information technology in manufacturing and manufacturing systems. Product life cycle & its importance. Technology life cycle. Scope, importance and challenges in Indian context to manufacture products at international competitive price with better quality& innovation. **5Hrs**

2. **Group Technology (GT) & Cellular Layout:** GT - concept, definition, need, scope, & benefits. Production layout-types, features and applications.GT Layout -concept, need, benefits, comparison with conventional layout with examples. GT- codification systems- types, method of coding and examples. Part features- concept, types and examples. Part family-concept, method to form and approach to form cell using part families. Types and comparison of cell: manual and automatic cell, assembly cell. Steps of cell design and cell layout. **12Hrs**

3. **Flexible Manufacturing System (FMS):** Flexible Manufacturing System (FMS) –concept, definition and comparison with other manufacturing systems. Major elements of FMS and their functioning MS layout - concept, types and applications. Data required developing an FMS layout. Signal flow diagram and line balancing in FMS. FMS layout illustrations (Minimum two). **7Hrs**

Part-B

4. **Robotics:** Robots-concept, definition, benefits and various areas of application in manufacturing systems. Terminology used in robotics. Robots-types, physical configuration, classification and selection criterion. Axes nomenclature. Types and uses of Manipulators &

Grippers. Sensors- types, classifications, working principle and applications of position, force & torque, proximity, vision, velocity & acceleration sensors. Overview of robot programming methods & languages.Transaction Management and Concurrency Control ACID properties, failure and recovery, concurrency control, serializability, two phase locking protocols, Timestamp and Validation based protocols, deadlocks, logs and logging protocol. **8Hrs**

5. **Recent Trends:** Computer Aided Process Planning (CAPP) - concept, types, features, methods and importance. Computer Integrated Manufacturing (CIM): need, block diagram, functional areas covered and their importance. Protocols in CIM- their features, functions and applications. Computer Aided Inspection (CAI) - concept, benefit, types, working and examples. Coordinate Measuring Machine (CMM) - its working and applications. Artificial intelligence- concept, definition and application areas, neural network: working principles, applications and limitations. Lean manufacturing - concept, sources of waste, benefits and applications. Factory of future (FOF). **10Hrs**
6. **Advanced Topics:** Role of control system in instrumentation .Open and close loop control system, types and block diagram. Rapid Prototyping (RP): working principles, methods, applications and limitations, rapid tooling, techniques for rapid prototyping. **7Hrs**

Text Books:

1. P. Radhakrishnan & S. Subranarayan, CAD/CAM/CIM, New Age Intentional
2. Bedworth, Wolfe and Anderson, Computer Integrated Design & Manufacturing by McGraw Hill International Publication.
3. Arthur J. Critchlow, Introduction to Robotics, McMillan publication
4. Yorom Koran, Robotics for engineers, McGraw Hill Publication
5. Rao, Tiwari & Kundra, Computer aided manufacturing, Tata McGraw Hill Publication

Reference Books:

1. Dr Sadhu Singh, Computer Aided Design & Manufacturing. K. Publisher.
2. S.K.Vajpayee, Computer Integrated Manufacturing. PHI Publisher.

Subject Code: PEME-314 **Subject Name: Plastic Technologies**

Programme: B.Tech. ME	**L:** 4**T: 0 P:** 0
Semester: 7th /8th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective IV

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Analyse properties of plastic material according to requirement.
2.	Understand the advantage of using plastic over other materials.
3.	Design various products for different application as a plastic material.
4.	Apply different processes to convert plastic in finished good.
5.	Analyse the plastic storage problems.
6.	Analyse and reduce the problems such as flammability, toxic fumes, limitation of working under heat etc.

Detailed Contents:

Part-A

1. **Plastic Materials**: Plastics as a material, their load bearing capacity, effect of temperature, sunlight, load/stress, humidity, oxidation etc. on plastics. **12Hrs**
2. **Advantages of plastic materials:** Advantages of using plastics in comparison with other conventional materials (wood, steel) such as, reduction in weight by using specific weight concept, reduction in number of parts during construction, increased possibilities in number of shapes, new products, cost effectiveness and aesthetics, reusability. **8Hrs**
3. **Plastic Applications**: Applications of plastics in various areas such as agriculture, packaging, electrical and electronics, automobile, construction, sports, medical engineering and household etc. **8Hrs**

Part-B

4. **Plastic Conversion**: Preliminary ideas of extrusion, injection molding, blow, molding, rotational molding, compression and transfer molding taking examples of commonly used products made by each process. **12Hrs**
5. **Plastic Storage**: Storage and handling of plastics and chemicals used in plastics industry (such as resins, solvents, plasticizers, pigments etc), and problems such as flammability, toxic fumes, limitation of working under heat etc. **8Hrs**

Text Books:

1. lrwin rubin “Hand book of Plastic Materials and technology”
2. Berins , “Plastics engineering hand book” - society of the Plastics industry
3. William, J.P., Plastics Technology, Tarapore Vela sons pub.
4. Allen , WS & baker , pn “Hand book of Plastics technology

5. Manzoor, Javid, et al. "Plastic waste environmental and human health impacts." Handbook of Research on Environmental and Human Health Impacts of Plastic Pollution. IGI Global, 2020.

Reference Books:

1. Satsangi, Aparna. "Plastic Pollution and Its Remedies: An Indian Scenario." Handbook of Research on Environmental and Human Health Impacts of Plastic Pollution. IGI Global, 2020. 142-159.
2. Sofi, Irfan Rashid, et al. "Plastic pollution and the ecological impact on the aquatic ecosystem." Handbook of Research on Environmental and Human Health Impacts of Plastic Pollution. IGI Global, 2020. 80-93.

Subject Code: PEME-315 **Subject Name: Composite Materials**

Programme: B.Tech.	**L:** 4 **T: 0 P:** 0
Semester: 8TH	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 10-20
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Elective V

Prerequisites: Nil

Additional Material Allowed in ESE: Nil

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes
1.	Understand the applications of composite materials.
2.	Identify various constituents of composite materials and their characteristics.
3.	Suggest and use standard methods for determining mechanical properties of different types of composite materials.
4.	Apply various techniques for processing of composite materials.
5.	Apply the basic concepts of micro-mechanics of composite laminates.
6.	Analyze failure modes of composite.

Detailed Contents:

Part-A

1. **Introduction:** History of composite materials, classification of composite materials, properties of composites compared to conventional materials, applications of composites. **4 Hrs**
2. **Matrices and Reinforcements:** Introduction to different types of matrices; difference between thermosetting and thermoplastic matrices, chemical structure and characteristic features of polymer matrices, curing system; role of matrix in continuous fibre composites; introduction to different types of reinforcements; characteristic features and role of fibres, particles, whiskers as reinforcing agents. **10 Hrs**
3. **Basic Concepts of Composite Materials:** Stress distribution in fibre and matrix, rule of mixtures, analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, estimation of minimum and critical amount of reinforcement, experimental determination of mechanical properties (compressive, flexural and shear) of composite materials using standard test procedures; failure theories of polymer matrix composites. **14 Hrs**

Part-B

4. **Processing of Composite Materials**: Processing techniques of polymeric matrix composites (PMCs); process mechanism, capability and application areas of various techniques; hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds; primary processing techniques for ceramic and metal matrix composites (CMCs and MMCs); stir and squeeze casting, powder metallurgy, liquid infiltration process **10Hrs**

5. **Secondary Processing of Composite Materials**: Machining, welding, adhesive joining and mechanical fastening of composite materials (as relevant and specific for PMCs, CMCs and MMCs). **10 Hrs**

Suggested Books/Readings:

1. Mathews F.L and Rawlings R.D, Composite Materials: Engineering and Science, Woodhead Publishing, ISBN: 9781855734739, 1st Edition, 1999.
2. Hull D. and Clyne T.W., An Introduction to Composite Materials, 2nd Ed., Cambridge University Press, 2013
3. Chawla K.K., Composite Materials: Science and Engineering 3rd Ed., Springer, 2012
4. Chawla K.K., Ceramic Matrix Composites, 2nd Ed., Springer, 2003
5. Chawla N. Chawla K.K., Metal Matrix Composites, 2nd Ed. Springer, 2013

Reference Books:

1. Shojiro O., Mechanical Properties of Metallic Composites, Marcel Dekker, 2002
2. Deborah D.L. Chung, Composite Materials: Science and Applications, 2nd Ed. Springer, 2010

Online Courses and Video Lectures:

3. **https://nptel.ac.in/courses/112/104/112104229/**
4. **https://nptel.ac.in/courses/112/104/112104168/**
5. **https://nptel.ac.in/courses/101/104/101104010/**
6. **https://nptel.ac.in/courses/112/104/112104221/**
7. **https://nptel.ac.in/courses/112/104/112104249/**

Subject Code: OEME-101 **Subject Code: Industrial Safety and Environment**

Programme: B.Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 7^{th} /8^{th}	**Teaching Hours:** 36 Hours
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 0%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Open Elective II

Additional Material Allowed in ESE: NIL

On Completion of the course, the student will have the ability to:

CO	Course Outcomes
1.	Use and design safety equipment /systems effectively.
2.	Understand the methods of hazard identification and preventive measures
3.	Apply the methods of prevention of fire and explosions.
4.	Understand the control and relief and methods.
5.	Maintain the safer environment in the industry

Detailed Contents:

Part-A

1. **Safety**: Measuring and need for safety. Relationship of safety with plant design, equipment design and work environment. Use of various Personal Protective Equipment (PPEs), Industrial accidents, their nature, types and causes. Assessment of accident costs; prevention of accidents. Industrial hazards, Hazards identification techniques, accident investigation, reporting and analysis. **6Hrs**
2. **Environmental control and safety:** Environmental factors in industry. Effect of temperature, illumination, humidity noise and vibrations on human body and mind. Measurement & mitigation of physical and mental fatigue. Basics of environment design for efficiency and accuracy enhancement. Environment standard; Introduction to ISO 14000; Environmental standard for representative industries. **5Hrs**
3. **Ventilation and heat control**: Purpose of ventilation. Physiology of heat regulation. Thermal environment and its measurement. Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Types of ventilation. Air conditioning process & types. **5Hrs**
4. **Industrial Lighting:** Purpose of lighting, benefits of good illumination, Phenomenon of lighting and safety, Lighting at work source, types of artificial lighting. Principles of good illumination. Recommended optimum standards of illumination. Design of lighting system. Maintenance standard relating to lighting and colour. **6Hrs**

Part-B

5. **Noise and Vibrations:** Various types of noise. The effect of noise on worker. Noise measurement and evaluation of noise. Noise control techniques. Vibrations; Effect, types, measurement and control measures. **5Hrs**
6. **Fire, Explosion & Prevention:** The fire triangle, Distinction between Fires and Explosions, Flammability Characteristics of Materials, Ignition Sources, Sprays and Mists. Concepts to Prevent Fires and Explosions: Static Electricity and its Control, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems, Fire- fighting equipment. **4Hrs**
7. **Miscellaneous:** Safety and economics, safety and productivity. Employees' participation in safety. Safety standards and legislation. First aid provisions and training. **5Hrs**

Text Books:

1. Gupta, A.K., “Industrial Safety & Environment” Laxmi Publishers.
2. Asfahal, C.R. and Rieske, D.W., “Industrial Safety and Health Management”, Pearson.
3. Hammer, W. and Price, D., “Occupational Safety Management and Engineering”. Pearson.
4. DC Reamer; R , “Modern Safety & Health Technology”, Wiley.
5. Heinrich, H.W., “Industrial Accident prevention”, McGraw Hill.

Subject Code: OEME-102 **Subject Name: Management Information System**

Programme: B.Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 36 Hours
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 0%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Open Elective III

Additional Material Allowed in ESE: NIL

On Completion of the course, the student will have the ability to:

CO	Course Outcomes
1.	Understand the need of MIS in organization, business process integration with IT
2.	Understand SCM, CRM, ESS, DSS, EDI & E-Commerce
3.	Identify, formulate and implement different strategies for competitive advantage
4.	Study and analyze the Business Intelligence techniques
5.	Monitor the challenges and changes in IT in an organization

Detailed Contents:

Part-A

1. **Introduction to Management Information systems:** Types of MIS, Capabilities, Complements, CCR Framework; Role of manager with respect to IT in an organization, Challenges for the manager, Decision making with MIS-Tactical decisions-operational decisions, strategic decisions, communication in organizations- types of communication. **7Hrs**
2. **Database management systems**: Data Warehousing, Basics of data mining. **3Hrs**
3. **Strategic Enterprise Systems:** Enterprise Resource Planning (ERP), Supply Chain Management, Customer Relationship Management. Challenges of Enterprise Systems Implementations, International Information Systems-Outsourcing and off-shoring. **6Hrs**

Part-B

4. **E-commerce Technology:** Business over internet, Electronic Data Interchange (EDI), online payment technology, E-business (Mobile and E-commerce – B2C, B2B, C2C and mobile commerce), and E-procurement. **8Hrs**
5. **Operational Support Systems:** Manufacturing Systems, Sales and Marketing Systems, HRIS, Finance and Accounting Systems. **6Hrs**
6. **Knowledge Management:** Decision Support Systems and Business Intelligence techniques, Expert Systems, Learning Management Systems, Executive Information Systems, Executive Support System. Vendor Management- vendor selection, vendor development, vendor retention or termination. **6Hrs**

Text Books:

1. S.A Kelkar ,"Management Information System", PHI Learning Pvt. Ltd..
2. A.K Gupta , "Management Information Systems", S. Chand & Company Ltd.
3. C.S.V.Murthy, "Management information systems", Himalya Publishing House.

Reference Books:

1. Kenneth C. Laudon, Jane P. Laudon, "Management Information Systems", Pearson.
2. R. Kelly Rainer, Hugh J. Watson , "Management Information Systems", Down Felly.

Subject Code: OEME-103 **Subject Name: Entrepreneurship**

Programme: B.Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**Teaching Hours:** 36 Hours
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design Problems:** 0%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hours
Total Marks: 100	**Elective Status:** Open Elective I

Additional Material Allowed in ESE: NIL

On Completion of the course, the student will have the ability to:

CO	Course Outcomes
1.	Concept and theories of entrepreneurship and its role in economic development.
2.	Develop business plan and identify the reasons of failure of business plans.
3.	Illustrate the steps in starting MSME.
4.	Comprehend government policies and regulatory framework available in India to facilitate the process of entrepreneurial development.
5.	Identify different sources of finance for new enterprises and assess the role of financial institutions and various government schemes in entrepreneurial development
6	Assess the role of financial institutions and various government schemes in entrepreneurial development

Detailed Contents:

Part-A

1. **Basics of Entrepreneurship**: Concept of Entrepreneurship, Theories of Entrepreneurship, Myths about Entrepreneurship, Entrepreneurial Traits and Motivation, Role of Entrepreneurship in economic development. Types of Entrepreneurs. Barriers in the way of Entrepreneurship. Entrepreneurship Development (ED) Cycle. Entrepreneurship development programmes (EDP). **6Hrs**
2. **Identification of Investment Opportunities**: Creativity and Business Ideas, Blocks to creativity. Business Plans and reasons of failure of business plans. Micro-Small-Medium Enterprise (MSME) & its role in developing countries- Steps and problems for starting. Government policies for industry and regulatory framework, foreign collaboration and investment. Scouting for project ideas, preliminary screening & pilot run /prototype modeling. **8Hrs**
3. **Market and Demand Analysis**: Information required for market and demand analysis, market survey, demand forecasting, uncertainties in demand forecasting. **7Hrs**

Part-B

4. **EDP in India**, South Asia and World – Phases of Entrepreneurial programs – Government Policies & Initiatives, Administrative Frame work, Policy instruments , Statutory Boards , Industrial Estates, Industrial clusters, Incentives and subsidies, Promotional agencies. Business Incubators& Start-ups. **7Hrs**
5. **Financial Management**: Cost estimation, Types of capital, Budget Management, Bridge capital, Seed capital assistance, Margin money scheme, Industrial Sickness, Causes-Remedies- An overview on the roles of institutions/schemes in entrepreneurial

development- SIDBI, Commercial Banks. Other financing options- venture capital, lease funding, Angel Investors. Revival, Exit and End to a venture. **8Hrs**

Text Books:

1. Kumar & Arya(2018), "Entrepreneurship", Pearson, New Delhi.
2. Gopal & Nanda (2015), "Entrepreneurial Development", Vikas Publishing, New Delhi.
3. Desai & Vasant, "Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House.
4. Khanka,S S "Entrepreneurial Development", S.Chand & Co.,New Delhi.
5. Greene, Patricia G., and Mark P. Rice. Entrepreneurship education. Edward Elgar Publishing, 2007.

Subject Code: OEME-104 **Subject Name: Operations Management**

Programme:B.Tech. (M.E.)	**L:** 3 **T:** 0 **P:** 0
Semester: 8th	**Teaching Hours:** 36 Hours
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status: Open** Elective III

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#.	Course Outcomes (Cos)
1	Apply knowledge of mathematics, science and engineering.
2	Design and conduct experiments, as well as to analyze and interpret data.
3	Design a system, process to meet desired needs within realistic constraints.
4	Function on multidisciplinary teams.
5	Design and maintain the systems.
6	Plan, control and execute the different duties in an organization.

Detailed Contents:

Part-A

1. **Need And Scope - Of Operation Management**: Types of production system and their characteristics, productivity definition, types and measurements. **3Hrs**
2. **Product Design And Development**: Steps involved in product design and development, considerations of technical, ergonomic, aesthetic, economic and time factors. Use of concurrent engineering in product design and development. Discussion of case studies. Feasibility and locational analysis. **5Hrs**
3. **Planning and Forecasting:** Role of market survey and market research in preplanning, long medium and short range forecasting, objective and techniques of forecasting, smoothening and revision of forecast. **4Hrs**
4. **Production Planning**: Production planning objective and functions, Bill of material, Capacity and man power requirement planning, operation analysis and process planning, long range planning, aggregate planning; Objective, Strategies, graphical and mathematical techniques of aggregate planning, master production scheduling, MRP and MRPII Systems. **4Hrs**

Part-B

5. **Production Control:** Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up. Techniques of production control in job shop production, batch production and mass production systems. **4Hrs**
6. **Material Management**: Objectives, scope and functions of material management, planning, procurement, storing, ending and inventory control. Purpose of inventory, inventory cost, inventory control systems, Selective inventory control systems, Determination of EOQ, Lead time and reorder point. Methods of physical stock control. **5Hrs**
7. **Quality Control**: Meaning of quality and quality control, quality of design, quality of conformance and quality of performance, functions of quality control. Introduction to statistical quality control-control charts and sampling plans. **4Hrs**
8. **Management Information Systems:** Introduction to MIS, Steps in designing MIS, Role of Computers in MIS. **5Hrs**

9. **Maintenance Systems**: Type of maintenance, objective of maintenance, planned maintenance strategies, preventive maintenance, condition monitoring and total productive maintenance.

3Hrs

Text Books:

1. Charry, "Production and Operation Management",Tata-McGraw Hill
2. J.G. Monks, " Production/Operation Management",Tata-McGraw Hill
3. R.N. Nauhria and RajnishPrakash,"Management of systems", Wheeler Publishing, New Delhi
4. E. L. Grant and R.S. Leaven Worth, "Statistical Quality Control", McGraw
5. Chary, S. N. Production and operations management. McGraw Hill Education, 2017.

Reference Books:

1. Buffa and sarin "Modern Production/Operations Management",John Wiley and Sons.
2. Russell & Taylor "Operations Management",PHI.

Subject Code: MCME-101 **Subject Name: Environmental Science**

Programme: B.Tech. (ME)	**L:** 2 **T:** 0 **P:** 0
Semester: 7th /8th	**Teaching Hours:** 26
Theory/Practical: Theory	**Credits:** 0
Internal Marks: 40+10	**Percentage of Numerical/Design/Programming Problems:** 0%
External Marks: Nil	**Duration of End Semester Exam(ESE):**
Total Marks: 50	**Subject Status:** Mandatory

Prerequisites: NIL.

On completion of the course, the student will have the ability to:

CO#	Course Outcomes (CO)
1	Measure environmental variables and interpret results.
2	Evaluate local, regional and global environmental topics related to resource use and management.
3	Propose solutions to environmental problems related to resource use and management.
4	Interpret the results of scientific studies of environmental problems.
5	Describe threats to global biodiversity, their implications and potential solutions.

Detailed Contents:

PART -A

1. **Natural Resources:** Renewable and non-renewable resources: Natural resources and associated problems: Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people **02 Hrs**

2. **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems, Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers-pesticides problems, water logging, salinity, case studies, Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies, Land Resources: Land as a resource, land degradation, man induces landslides, soil erosion, and desertification. **04 Hrs**

3. **Eco Systems:** Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers, decomposers, Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem, Grass land ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) **04 Hrs**

4. **Biodiversity and it's Conservation:** Introduction-Definition: genetics, species and ecosystem diversity, Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local level, India as a mega diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts, Endangered and endemic spaces of India, Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity. **05 Hrs**

PART B

5. **Environmental Pollution:** Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear hazards. **02 Hrs**

6. **Solid waste Management:** Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies. **02 Hrs**

7. **Social issues and the Environment:** Form unsustainable to sustainable development, Water conservation, rain water harvesting, water shed management, Resettlement and rehabilitation of people; its problems and concerns, case studies, Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, Environment protection Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection act, Forest conservation act. **04 Hrs**

8. **Human population and the environment:** Population growth and variation among nations, Population explosionfamily welfare program, Environment and human health, Human rights, Value education, HIV / AIDS, Women and child welfare. **03 Hrs**

Text Books

1. Textbook of Environmental studies, Erach Bharucha, UGC
2. Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd
3. Environment Biology by Agarwal, K. C., Nidi Publ. Ltd. Bikaner.
4. Principle of Environment Science by Cunninghan, W.P.
5. Essentials of Environment Science by Joseph.