List of Courses Focus on Employability/ Entrepreneurship/ Skill Development

Department : *Mechanical Engineering*

Programme Name : *B.Tech.*

Academic Year : 2021-22

List of Courses Focus on Employability/ Entrepreneurship/Skill Development

Sr. No.	Course Code	Name of the Course
01.	ME03TPC01	Mechanics of Solid-I
02.	ME03TPC02	Kinematics of Machine
03.	ME03TES04	Engineering Thermodynamics
04.	ME04THS31	Business Communication and Presentation Skill
05.	ME04TPC03	Fluid Mechanics
06.	ME03TPC04	Dynamics of Machine
07.	ME04TPC05	Machine Drawing
08.	ME04TPC04	Manufacturing Science-I
09.	ME04PPC03	Fluid Mechanics Lab
10.	ME04PPC04	Dynamics of Machine Lab
11.	ME05TPC07	Fluid & Turbo Machinery
12.	ME05TPC08	Internal Combustion Engine
13	ME05TPC09	Machine Design – I
14.	ME05TPC10	Mechanics of Solid-II
15.	ME05TPE23	CAD/CAM
16.	ME05PPC05	Fluid Machinery lab
17.	ME05PPC06	Internal Combustion Engine Lab
18.	ME05PPE01	CAD / CAM Lab
19.	ME06TPC11	Heat and Mass Transfer
20.	ME06TPC12	Manufacturing Science-II
21.	ME06PPC07	Heat and Mass Transfer Lab
22.	ME06PSC01	Seminar
23.	ME06PPC08	Manufacturing Science Lab
24.	ME06TPE31	Measurement Metrology and Control
25.	ME06TOE21	Machine Design-II
26.	ME06TOE13	Operations Research
27	ME7TPC15	Power Plant Engineering

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28	ME7TPC16	Refrigeration & Air Conditioning
30	ME7TPC17	CAD-CAM
31	ME7LPC16	Refrigeration & Air Conditioning Lab
32	ME7LMP01	Minor Project
33	ME7LPS02	Seminar on Summer Training
34	ME8TPC18	Auto Mobile Engineering
35	ME8TPC19	Turbo Machinery
36	MEPATT2	Advanced Computer Aided Design
37	IPPATC1	Research Methodology & IPR
38	MEPAPT1	Numerical Simulation Lab
39	MEPATP1	Mechanics of Composite Materials
40	MEPATP2	Advanced Engineering Materials
41	MEPATP8	Design for Manufacturing & Assembly
42	MEPATP3	Mechanical Vibrations
43	MEPATP6	Advanced Mechanical Design
44	MEPBTT1	Advanced Engineering Design
45	MEPBTT2	Finite Elements in Design
46	MEPBTP5	Noise, Vibrations and Harshness
47	MEPBTP2	Optimization Techniques in Engineering Design
48	MEPHDT01	Mechatronic System Design
49	MEPHDT02	Reliability and Maintenance Engineering
50	MEPHDT03	Composite Materials
51	MEPHDT04	Material Characterization Techniques
52	MEPHDT05	Advanced Machining Processes
53	MEPHDT06	Micro and Precision Manufacturing
54	MEPHDT07	Industrial Automation
55	MEPHDT08	Engineering Design Methodology
56	MEPHDT09	Finite Element Methods in Engineering
57	MEPHDT10	Fracture, Fatigue and Failure Analysis
58	MEPHDT11	Metal Forming and Theory Of Plasticity
59	MEPHDT12	Energy Conservation and Waste Heat Recovery
60	MEPHDT13	Advanced Thermodynamics

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SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
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CBCS-NEW, STUDY & EVALUATION SCHEME
PROPOSED W.E.F. SESSION 2021-2022
B.Tech. II Year (SEMESTER III)

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
1.	MA203TBS07	Statistical Methods	3	1	-	30	70	100	4
2.	ME203TPC01	Engineering Thermodynamics	3	1	-	30	70	100	4
3.	ME203TPC02	Fluid Mechanics	3	1	-	30	70	100	4
4.	ME203TPC03	Mechanics of Solids-I	3	1	-	30	70	100	4
5.	ME203TPC04	Manufacturing Processes	3	-	-	30	70	100	3
6.	ME203TMC02	Mandatory Course – Indian Knowledge System-I	1	-	-	-	-	-	-
		Total	**16**	**4**	**-**	**150**	**350**	**500**	**19**
PRACTICALS									
1.	ME203PPC01	Fluid Mechanics Lab	-	-	2	30	20	50	1
2.	ME203PPC02	Mechanics of Solids Lab	-	-	2	30	20	50	1
		Total	**-**	**-**	**4**	**60**	**40**	**100**	**2**
GRAND TOTAL			**16**	**4**	**4**	**210**	**390**	**600**	**21**

Total Credits : **21**
Total Contact Hour : **24**
Total Marks : **650**

*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.
L-LECTURE, T-TUTORIAL, P-PRACTICAL, ESE –END SEMESTER EXAMINATION

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CBCS-NEW, STUDY & EVALUATION SCHEME
PROPOSED W.E.F. SESSION 2021-2022
B.Tech. II Year (SEMESTER IV)

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
1.	MA204TBS09	Numerical Analysis & Computer Programming	3	1	-	30	70	100	4
2.	ME204TPC05	Applied Thermodynamics	2	1	-	30	70	100	3
3.	ME204TPC06	Kinematics Of Machinery	2	1	-	30	70	100	3
4.	ME204TPC07	Mechanics Of Solid-II	3	1	-	30	70	100	4
5.	ME204TPC08	Machine Tool Technology	3	-	-	30	70	100	3
6.	ME204TPC09	Materials Science & Metallurgy	3	-	-	30	70	100	3
		Total	**16**	**4**	**-**	**180**	**420**	**600**	**20**
PRACTICALS									
1.	ME204PPC01	Manufacturing Tech. Lab	-	-	2	30	20	50	1
2.	ME204PPC02	Computer Aided Machine Drawing	2	-	2	30	20	50	3
		Total	**2**	**-**	**4**	**60**	**40**	**100**	**4**
GRAND TOTAL			**18**	**4**	**4**	**240**	**460**	**700**	**24**

Total Credits : **24**
Total Contact Hour : **26**
Total Marks : **700**

*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

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DEPARTMENT OF MECHANICAL ENGINEERING
CBCS-NEW, STUDY & EVALUATION SCHEME
W.E.F. SESSION 2021-2022

Year: B.Tech. 4thyear

SEMESTER- VII

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	INTERNAL ASSESSMENT	ESE	SUB-TOTAL	
1.	ME07TPC12	Refrigeration and Air Conditioning	3	1	-	30	70	100	4
2.	ME07TPE04	Professional Elective-04	3	0	-	30	70	100	3
3.	ME07TPE05	Professional Elective-05	3	0	-	30	70	100	3
4.	ME07TOE04	Open Elective-04	3	0	-	30	70	100	3
5.	ME07TMC04	Indian Constitution	3	0	-	-	-	-	-
		Total	**15**	**1**	**-**	**120**	**280**	**400**	**13**
PRACTICALS									
1.	ME07LPC08	Refrigeration and Air Conditioning Lab	-	-	2	30	20	50	1
2.	ME07LSC02	Seminar on Summer Training	-	-	3	50	-	50	1.5
3.	ME07LMP01	Minor Project	-	-	8	100	-	100	4
Total			**0**	**0**	**13**	**60**	**40**	**200**	**6.5**

Total Credits: 19.5
Total Contact Hour: 29
Total Marks: 600
*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

ME07TPE04 Professional Elective-04	**ME07TPE05 Professional Elective-05**
ME07TPE41 Finite Element Method	ME07TPE51 Power Plant Engineering
ME07TPE42 Theory of Vibration	ME07TPE52 Maintenance Management
ME07TPE43 Modeling and Simulation	ME07TPE53 Gas Dynamics and Jet Propulsion

ME07TOE03 Open Elective-04
ME07TOE41 Production Planning and Control
ME07TOE42 Optimization in Engineering Design
ME07TOE43 Manufacturing Automation

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Year: B.Tech. 4thyear

SEMESTER- VIII

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	INTERNAL ASSESSMENT	ESE	SUB-TOTAL	
1.	ME08TPC13	Solar Energy	3	1	-	30	70	100	4
2.	ME08TPE06	Professional Elective-06	3	0	-	30	70	100	3
3.	ME08TOE05	Open Elective-05	3	0	-	30	70	100	3
4.	ME08THS04	Elective from Humanity Science HS-04	3	0	-	30	70	100	3
		Total	**12**	**1**	**-**	**120**	**280**	**400**	**13**
PRACTICALS									
1.	ME08LMP02	Major Project	-	-	14	120	80	200	7
Total			**0**	**0**	**14**	**120**	**80**	**200**	**7**

Total Credits: 20
Total Contact Hour: 27
Total Marks: 600
*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

ME08TPE06 Professional Elective-06
ME08TPE61 Total Quality Management
ME08TPE62 Cryogenic Engineering
ME08TPE63 Additive Manufacturing
ME08TOE05 Open Elective-05
ME08TOE51 Automobile Engineering
ME08TOE52 Soft Computing
ME08TOE53 Intellectual Property Rights
ME08THS04 Elective from Humanity Science HS-04
ME08THS41 Supply Chain Management
ME08THS42 Management Information System
ME08THS43 **Principles of Management**

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DEPARTMENT OF MECHANICAL ENGINEERING
CBCS-NEW, STUDY & EVALUATION SCHEME
W.E.F. SESSION 2020-2021

Year: B.Tech. 3rdyear

SEMESTER- V

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	INTERNAL ASSESSMENT	ESE	SUB-TOTAL	
1.	ME05TPC07	Fluid & Turbo Machinery	3	0	-	30	70	100	3
2.	ME05TPC08	Internal Combustion Engine	3	0	-	30	70	100	3
3.	ME05TPC09	Machine Design – I	3	1	-	30	70	100	4
4.	ME05TPC10	Meehanics of Solid-II	3	1	-	30	70	100	4
5.	ME05TPE02	Professional Elective-02	3	0	-	30	70	100	3
		Total	**15**	**2**	**-**	**150**	**350**	**500**	**17**
PRACTICALS									
1.	ME05PPC05	Fluid Machinery lab	-	-	2	30	20	50	1
2.	ME05PPC06	Internal Combustion Engine Lab	-	-	2	30	20	50	1
3	ME05PPE01	CAD / CAM Lab			2	30	20	50	1
Total			**0**	**0**	**4**	**90**	**60**	**150**	**3**

Total Credits: 20
Total Contact Hour: 21
Total Marks: 650
*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

ME05TPE02 Professional Elective-02	
ME05TPE21 Innovation and Technology Management	
ME05TPE22 Innovation and Entrepreneurial Skills	
ME05TPE23 CAD/CAM	

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DEPARTMENT OF MECHANICAL ENGINEERING
CBCS-NEW, STUDY & EVALUATION SCHEME
W.E.F. SESSION 2020-2021

Year: B.Tech. 3rd year

SEMESTER- VI

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	INTERNAL ASSESSMENT	ESE	SUB-TOTAL	
1.	ME06TPC11	Heat and Mass Transfer	3	1	-	30	70	100	4
2.	ME06TPC12	Manufacturing Science-II	3	0	-	30	70	100	3
3.	ME06TPE03	Professional Elective-03	3	0	-	30	70	100	3
4.	ME06TOE01	Open Elective-01	3	0	-	30	70	100	3
5.	ME06TOE02	Open Elective-02	3	1	-	30	70	100	4
6.	ME06TMC03	Essence of Traditional Knowledge	3	0	-	-	-	-	-
		Total	**18**	**2**	**-**	**150**	**350**	**500**	**17**
PRACTICALS									
1.	ME06PPC07	Heat and Mass Transfer Lab	-	-	3	30	20	50	1.5
2.	ME06PSC01	Seminar	-	-	2	50	-	50	1
3	ME06PPC08	Manufacturing Science Lab	-	-	3	30	20	50	1.5
Total			**0**	**0**	**6**	**110**	**40**	**150**	**4**

Total Credits: 21
Total Contact Hour: 26
Total Marks: 650
*INTERNAL ASSESSMENT- Two Class Test of 15 Marks each will be conducted.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

ME06TPE03 Professional Elective-03	**ME06TOE01 Open Elective-01**
ME06TPE31 Measurement Metrology and Control	ME06TOE11 Enterprise Resource Planning
ME06TPE32 Industrial Automation	ME06TOE12 Decision Support and Executive Information System
ME06TPE33 Advanced Manufacturing System	**ME06TOE13 Operations Research**
ME06TOE02 Open Elective-02	
ME06TOE21 Machine Design-II	
ME06TOE22 Mechatronics	
ME06TOE23Robotics and Robot Applications	

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CBCS-NEW, STUDY & EVALUATION SCHEME
PROPOSED W.E.F. SESSION 2021-2022
M.Tech. I Year (SEMESTER II)

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
1.	MEPBTT1	Advanced Engineering Design	3	-	-	40	60	100	3
2.	MEPBTT2	Finite Elements in Design	3	-	-	40	60	100	3
3.	MEPBTP1	Professional Elective-4	3	-	-	40	60	100	3
4.	MEPBTP2	Professional Elective-5	3	-	-	40	60	100	3
5.		Open Elective	3	-	-	40	60	100	3
6.		Audit Course	2	-	-	40	60	100	2
		Total	**17**	**-**	**-**	**240**	**360**	**600**	**17**
PRACTICALS									
1.	MEPBPT1	Design Lab	1	-	2	30	20	50	2
2.	MEPBPT2	Modeling and Analysis Lab	1	-	2	30	20	50	2
		Total	**2**	**-**	**4**	**60**	**40**	**100**	**4**
GRAND TOTAL			**19**	**-**	**4**	**300**	**400**	**700**	**21**

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Total Credits : **21**
Total Contact Hour : **23**
Total Marks : **700**

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*INTERNAL ASSESSMENT- Two Class Test of 20 Marks each will be conducted.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

Professional Elective-4	Professional Elective-4	Open Elective
Product Design and Development	Computational Fluid Dynamics	Business Analytics
Fracture Mechanics	Smart Materials & Structures	Operations Research
Theory of Plates and Shells	Optimization Techniques in Engineering Design	Industrial Safety
Noise, Vibrations and Harshness	Rotor Dynamics	Composite Materials
		Waste to Energy
		Internet of Things
		Cost Management of Engineering Projects
		MOOCs

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PROPOSED W.E.F. SESSION 2021-2022
M.Tech. I Year (SEMESTER I)

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
1.	MEPATT1	Advanced Mechanics of Solids	3	-	-	40	60	100	3
2.	MEPATT2	Advanced Computer Aided Design	3	-	-	40	60	100	3
3.	MEPATP1	Professional Elective-1	3	-	-	40	60	100	3
4.	MEPATP2	Professional Elective-2	3	-	-	40	60	100	3
5.	MEPATP3	Professional Elective-3	3	-	-	40	60	100	3
6.	IPPATC1	Research Methodology & IPR	2	-	-	40	60	100	2
		Total	**17**	**-**	**-**	**240**	**360**	**600**	**17**
PRACTICALS									
1.	MEPAPT1	Numerical Simulation Lab	1	-	2	30	20	50	2
		Total	**1**	**-**	**2**	**30**	**20**	**50**	**2**
GRAND TOTAL			**18**	**-**	**2**	**270**	**380**	**650**	**19**

Total Credits : **19**
Total Contact Hour : **20**
Total Marks : **650**

*INTERNAL ASSESSMENT- Two Class Test of 20 Marks each will be conducted.
L-LECTURE, T-TUTORIAL, P-PRACTICAL, ESE –END SEMESTER EXAMINATION

Professional Elective-1	Professional Elective-2	Professional Elective-3
Tribology and Surface Engineering	Advanced Engineering Materials	Advanced Synthesis of Mechanisms
Mechanics of Composite Materials	Design and Analysis of Experiments	Mechanical Vibrations
Design of Thermal Systems	Design for Manufacturing & Assembly	Advanced Mechanical Design

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Department of Mechanical Engineering, School of Engineering & Technology, GGV, Bilaspur (C.G.)

DEPARTMENT OF MECHANICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.), 495009
EVALUATION SCHEME OF Pre-Ph. D COURSE WORK
EFFECTIVE FROM SESSION 2021-22

SN.	Name of the Subject	Subject Code	Periods / Week L – T – P	ESE Duration	ESE MARKS		Credits
					Max.	Min.	
1	Research Methodology in Engineering	ETPHDT00	3 – 1 – 0	3 Hrs.	100	40	4
2	Elective - I	**	3 – 1 – 0	3 Hrs.	100	40	4
3	Elective - II	**	3 – 1 – 0	3 Hrs	100	40	4
4	Seminar	ETPHDS00	-	-	Qualified/Not qualified		---
Total			9 – 3 – 0	-	300	165*	12

Duration of the semester will be 6 months.
*Candidate has to score minimum 55% of the aggregate marks to qualify in ESE.
Two core subjects as Electives (4 credits each) to be decided by the DRC.

LIST OF ELECTIVES		**	LIST OF ELECTIVES		**
SN	Name of the Subject	Subject Code	SN	Name of the subject	Subject Code
1	Mechatronic System Design	MEPHDT01	9	Finite Element Methods in Engineering	MEPHDT09
2	Reliability and Maintenance Engineering	MEPHDT02	10	Fracture, Fatigue and Failure Analysis	MEPHDT10
3	Composite Materials	MEPHDT03	11	Physics of Manufacturing Processes	MEPHDT11
4	Materiai Characterization Techniques	MEPHDT04	12	Energy Conservation and Waste Heat Recovery	MEPHDT12
5	Advanced Machining Processes	MEPHDT05	13	Supply Chain and Logistic Performance Management	MEPHDT13
6	Micro and Precision Manufacturing	MEPHDT06	14	Production and Operations Management	MEPHDT14
7	Industrial Automation	MEPHDT07	15	Design Of Solar Thermal Systems and Applications	MEPHDT15
8	Engineering Design Methodology	MEPHDT08	17	Modeling and Analysis of Solar Systems	MEPHDT16

L : Lecture. T: Theory, P: Practical, Max.: Maximum Marks in ESE; Min.: Minimum Pass Marks in each subject as 40

विभागाध्यक्ष / Head
यांत्रिकी अभियांत्रिकी विभाग / Mechanical Engg. Dept.
प्रौद्योगिकी संस्थान / Institute of Technology
गुरु घासीदास वि.वि. / Guru Ghasidas V.V.
कोनी, बिलासपुर (छ.ग.) / Koni, Bilaspur (C.G.)

ME203TPC01 – ENGINEERING THERMODYNAMICS

1.	**Departmeut/Center proposing the course**	Mechanical Engineering
2.	**Course title**	**Eugineering Tbermodynamics**
3.	**L-T-P Structure**	3-1-0
4.	**Credits**	4
5.	**Course number**	ME203TPC01
6.	**Status (Category for program)**	**Professional Core**

7.	**Pre-requisites**	Nil

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1.	Overlap with any UG/PG course of the Dept./Centre	No
8.2.	Overlap with any UG/PG course of other Dept./Centre	No
8.3.	Super cedes any existing course	No

9.	Not allowed for **(indicate program names)**	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **3th sem**

11.	**Faculty who will teacb the course**	Expertise or specialization in the Fluid Thermal sciences

12.	**Will the course require any visiting faculty**	No.

13.	**Course contents***(about 100 words) (include laboratory/design activities)*: First and Second laws of thermodynamics, Entropy, Availability, Properties of gases and mixtures, Thermodynamic relations

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	Introduction, thermodynamic properties, equilibrium, zeroth and first laws of thermodynamics, work and heat transfer interactions	11

2	First law for closed system, first law for open system, second law of thermodynamics	12
3	Entropy, Availability, exergy and irreversibility	11
4	Thermodynamic relations, equilibrium and third law	11
5	Properties of Gases and Mixtures	11
TOTAL HOURS (including Tutorials)		56

15. Brief description of tutorial activities

Tutorial classes are for application-based problem solving

16. Suggested texts and reference materials

Text Books:

- Engineering Thermodynamics – P.K. Nag, McGraw Hill
- Basic and Applied Thermodynamics – P.K. Nag, McGraw Hill

Reference Books:

- Fundamentals of Thermodynamics – Sonntag, Borgnakke, Van Wylen, Wiley
- Thermodynamics-An engineering approach – Cengel and Boles, McGraw Hill

ME203TPC02 – FLUID MECHANICS

1.	**Department/Center proposing the course**	Mechanical Engineering
2.	**Course title**	**Fluid Mecbanics**
3.	**L-T-P Structure**	3-1-0
4.	**Credits**	4
5.	**Course number**	ME203TPC01
6.	**Status (Category for program)**	**Professional Core**

7.	**Pre-requisites**	Nil

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1.	Overlap with any UG/PG course of the Dept./Centre	No
8.2.	Overlap with any UG/PG course of other Dept./Centre	No
8.3.	Super cedes any existing course	No

9.	Not allowed for (**indicate program names**)	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **3th sem**

11.	**Faculty who will teach the course**	Expertise or specialization in the Fluid Thermal sciences

12.	**Will the course require any visiting faculty**	No.

13.	**Course contents***(about 100 words) (include laboratory/design activities)*: Introduction and basic concepts, properties of fluids, fluid statics, kinematics, Bernoulli and energy equations, momentum analysis, flow in pipes, dimensional analysis, differential analysis of fluid flow, flow over bodies

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	Introduction and basic concepts, properties of fluids, pressures and fluid statics	11
2	Fluid kinematics, fundamentals of flow visualization, vorticity	12

	and rotationality, Reynolds transport theorem, mass conservation, Bernoulli's and energy equations	
3	Flow in pipes, laminar and turbulent flow in pipes, minor and major losses, piping networks, flow measurements	11
4	Momentum analysis of fluid flow, linear and angular momentum, dimensional analysis and similitude	11
5	Differential analysis of fluid flow, mass continuity and momentum equations, Navier-Stokes equations, Flow over bodies – drag and lift for flat plates, cylinders and spheres	11
TOTAL HOURS (including Tutorials)		56

15. Brief description of tutorial activities

Tutorial classes are for application-based problem solving

16. Suggested texts and reference materials

Text Books:

- Fluid Mechanics-Fundamentals and Applications – Cengel&Cimbala, McGraw Hill
- An Introduction to Fluid Mechanics & Fluid Machines –Som& Biswas, McGraw Hill

Reference Books:

- Fluid Mechanics – FM White, McGraw Hill
- Engineering Fluid Mechanics – K.L. Kumar, S.Chand& Co.

ME203TPC03 – MECHANICS OF SOLIDS – I

1.	**Department/Center proposing the course**	Mechanical Engineering
2.	**Course title**	**Mechanics of Solids -I**
3.	**L-T-P Structure**	3-1-0
4.	**Credits**	4
5.	**Course number**	ME203TPC03
6.	**Status (Category for program)**	**Professional Core**

7.	**Pre-requisites**	Engineering Mechanics

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1.	Overlap with any UG/PG course of the Dept./Centre	No
8.2.	Overlap with any UG/PG course of other Dept./Centre	No
8.3.	Super cedes any existing course	No

9.	Not allowed for (**indicate program names**)	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **3th sem**

11.	**Faculty who will teach the course**	Expertise or specialization in the Design

12.	**Will the course require any visiting faculty**	No.

13.	**Course contents***(about 100 words) (include laboratory/design activities):* Introduction to stress, strains, properties of materials, Beams , stresses and deflection in beams, torsional stresses in shafts, combined stresses due to different types of loads

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	Basic of Stress & Strain, elastic constants, stress – strain diagram, Hooke's law, Poisson's ratio, shear stresses, stresses in the components subjected to multi-axial forces, thermal stresses,	11

	statically indeterminate systems	
2	(A) **Beams:** Introduction of Beams, Various type of Beams, Various type of Supports, Reactions at supports, Shear force and bending moment at any section of a beam, Relation between Shear Force and Bending Moment, Point of contra-flexure. (B) **Bending of beams:** Bending of beams with symmetric section, boundary conditions, pure bending, and bending equation problems of simple bending	12
3	**Deflection of beam:** Relation between slope deflection and radius of curvature, solution of beam deflection, problem by Macaulay's method, Direct integration method, Moment Area Method, Conjugate Beam method	11
4	Deformation in circular shaft due to torsion, basic assumptions, torsion equations, stresses in elastic range, angular deflection, hollow & stepped circular shaft, analysis of closed coil helical spring.	11
5	**(A) Principal stresses and strain**: Transformation of plane stresses, Principal stresses, Maximum shear stresses, Mohr's circle for plane stresses, Plain strain and its Mohr's circle representation, Principal strains, Maximum shear strain. **(B) Comhined Loading**: Components subjected to bending, torsion & axial loads	11
TOTAL HOURS (including Tutorials)		56

15. Brief description of tutorial activities

Tutorial classes are for application-based problem solving

I6. Suggested texts and reference materials

Text Books:

1. Elements of Strength of Material – S.P. Timoshenko & D.H. Young- AEWP .
2. Strength of Materials by Sadhu Singh.

Reference hooks:

1. An Introduction of mechanics of solid by Crandall, Dahl &Lardnee Tata McGraw Hill.
2. Advance Strength of Materials by L.S. Srinath
3. Mechanics of material by F.P. Beer & E.R. Johnson Jr. Tata McGraw Hil.
4. Engineering Mechanics of solids by Egor P. Popov., PHI
5. Introduction of solid mechanics by I. H. Shames

ME203TPC04 – MANUFACTURING TECHNOLOGY

1.	**Department/Center proposing the course**	Mechanical Engineering
2.	**Course title**	**Manufacturing Technology**
3.	**L-T-P Structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ME203TPC04
6.	**Status (Category for program)**	**Professional Core**

7.	**Pre-requisites**	Nil

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1.	Overlap with any UG/PG course of the Dept./Centre	No
8.2.	Overlap with any UG/PG course of other Dept./Centre	No
8.3.	Super cedes any existing course	No

9.	Not allowed for **(indicate program names)**	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **3th sem**

11.	**Faculty who will teach the course**	Expertise or specialization in the Manufacturing or Production domain

12.	**Will the course require any visiting faculty**	Visiting faculties or professional persons from manufacturing industries are required.

13.	**Course contents***(about 100 words) (include laboratory/design activities)*: The significant contents to be address under MS is depicted below: The welding, resistance welding, foundry, melting furnaces & practices, casting, forming, rolling, extrusion and sheet-metal working.

14. **Lectnre outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1.	**Introduction and classification of manufacturing and type of current**	

	manufacturing processes. **Welding:** Classification of welding process, basic principal & scope of application, Principle of Gas and electric arc welding, TIG& MIG processes and their parameters, characteristics of power sources, Polarity, soldering, brazing, electrodes, types & coatings, welding defects and remedies, Principle, equipments& types of Resistance welding:.	9
2	**Foundry:** Moulding methods and materials, sand-clay-water system, additives, types of moulding sand and their properties, pattern making and types, pattern allowances and design considerations, core making. **Melting furuaces and practices:** Melting cast iron, steel and non ferrous material, cupola, open furnaces, converter and crucible furnaces, electric, direct arc furnace and inductive furnace.	8
3	**Casting:** Elements of gating system-top gating, bottom gating, types of risers, solidification of casting, casting defects, clearing of casting, principle of die casting- gravity and pressure die casting, shell moulding, Centrifugal and investment casting, **Plastic processing:** injection, compression & blow moulding.	8
4	**Forming:** mechanism of forming process, elastic and plastic deformation. **Rolling:** classification, theories of Hot & Cold rolling, rolling mills & its types, calculation of rolling parameter & rolling defect, roll pass sequence. **Forging:** Basic operations and their classification and defects. **Extrusion:** Classification and principle of extrusion process, analysis of processes, drawing of rods, wire tube-analyses of wire drawing, tube drawing, defects in extrusion & drawing	9
5	**Sheet-metal working:** Role of sheet metal Components, description of cutting processes-blanking, piercing, stripper and stock guide, description of forming processes like bending, cup drawing, coining, embossing. **Basic elements of press**- classification, punch and die clearances, elements of die and punches, clearance, compound ,combination, progressive and inverted dies and their operations	8
	TOTAL HOURS	42

15. Brief description of tutorial activities

NA

16. Suggested texts and reference materials

Reference Books:

- *R. A.Lindberg (1990), Processes and Materials of Manufacture, 4th Edition, PHI learning Publication.*
- *Ghosh (2010), Manufacturing Science, second edition, East-West Press Pvt LTD.*
- *Manufacturing Science.*
- *5. A. Mubeen and M. Parvez (2012), Manufacturing Science, Edition: 1st, Publisher-asian books private limited, ISBN: 818412167-9*

ME204TPC05 – APPLIED THERMODYNAMICS

1.	**Department/Center proposing the course**	Mechanical Engineering
2.	**Course title**	**Applied Thermodynamics**
3.	**L-T-P Structure**	2-1-0
4.	**Credits**	3
5.	**Course number**	ME204TPC06
6.	**Status (Category for program)**	**Professional Core**

7.	**Pre-reqnisites**	Engineering Thermodynamics

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	Yes
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Super cedes any existing course	Yes

9.	Not allowed for **(indicate program names)**	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **4th sem**

11.	**Facnlty who will teach the course**	Expertise or specialization in the Fluid Thermal sciences

12.	**Will the course require any visiting faculty**	No

13.	**Course contents***(about 100 words) (include laboratory/design activities)*: Properties of Pure substances, Vapour power cycles, Gas power cycles, Refrigeration Cycles, Compressible fluid flow, Kinetic theory of gases

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	Gas power cycles – Carnot, Stirling Ericsson, Air standard, Otto, Diesel, Dual Brayton cycles, Aircraft propulsion	9
2	Properties of pure substances, thermodynamic processes for pure substance, steam tables, charts of thermodynamic properties	8
3	Vaopur Power cycles, Rankine cycle, regenerative cycle, exergy analysis of vapor power cycles binary vapor cycles	9
4	Refrigeration cycles – reverses heat engine cycle, vapor compression, vapor absorption, gas refrigeration cycle, production of solid ice, Psychrometrics	8
5	Compressible fluid flow – stagnation properties, one dimensional steady isentropic flow, critical properties, shocks, introduction to kinetic theory of gases	8
	TOTAL HOURS (including Tutorials)	42

ME204TPC06 – KINEMATICS OF MACHINERY

1.	**Department/Center proposing the conrse**	Mechanical Engineering
2.	**Course title**	**Kinematics of machinery**
3.	**L-T-P Structure**	2-1-0
4.	**Credits**	3
5.	**Course number**	**ME204TPC06**
6.	**Status (Category for program)**	**Professional Core**

7.	**Pre-requisites**	Engg. Mechanics

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1.	Overlap with any UG/PG course of the Dept./Centre	No
8.2.	Overlap with any UG/PG course of other Dept./Centre	Yes (TOM)
8.3.	Super cedes any existing course	No

9.	Not allowed for **(indicate program names)**	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **4th sem**

11.	**Faculty who will teach tbe course**	Expertise or specialization in the Design

12.	**Will the course require any visiting faculty**	No.

13. **Course contents***(about 100 words) (include laboratory/design activities)*:

Introduction and basic concepts, Mechanisms, Velocity & Acceleration Analysis, Gears & Gear Trains, cam and follower, Clutch,Brakes

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	Introduction and basic concepts, Mechanism and Machines, Links, kinematics pair, kinematics chain, degree of freedom & constrained motion, inversion of slider crank mechanism, four bar chain etc. equivalent linkage, mechanism with lower pairs,	9

	pantograph.	
2	Plane motion, absolute and relative motion, velocity and acceleration of a point, velocity and acceleration of a mechanism by relative velocity diagram, Coriolis components.	9
3	Classification of gears, conjugate action, law of gearing, involutes and cycloidal tooth's profiles, interference and under cutting, contact ratio, gear train	8
4	Classification of cam and follower, types of follower motion, uniform, simple harmonic, parabolic, cycloid, Cam's profile by graphical method.	8
5	Clutch: Calculations on single plate and multi plate clutch, cone clutch Brakes: Analysis of simple brakes assuming uniform pressure and uniform wear, band brake, block brake, internal shoe brake.	8
	TOTAL HOURS (including Tutorials)	42

15. Brief description of tutorial activities

Tutorial classes are for application-based problem solving

16. Suggested texts and reference materials

Text Books:

- Mechanism of machines By Ghosh and Mallick East West Press
- Theory of machine By S.S. Ratan TMGH

Reference Books:

- Theory of Machine ByThomosBeven, C.B.S. Publications

	loading in tension and bending, Theorem of Castigliano and its applications, Reciprocal relations, Maxwell -Betti theorem.	
2	**Fixed Beams:** Fixed beam subjected to different types of loads and couples, Calculations of fixing moments and reactions at supports, deflection. Effect of sinking of support. **Continuons beams**: Continuous beams subjected to different type of loads and couples, beams with overhang, beams with one end fixed, Clapeyron's theorem. Effect of sinking of supports.	11
3	**Bending of curved bars:** Bending of curved bars in plane of loading, Winkler- Bach theory, crane hooks, chain links, bending of circular bars subjected to symmetric loading, bending of circular rings, stresses in circular rings	11
4	**Unsymmetrical Bending**: Introduction to unsymmetrical bending, Stresses and deflection in unsymmetric bending, Shear center for angle, Channel and I-sections. **Columns:** Struts and Columns, Stability of columns, Euler's formula for different end conditions, Equivalent load, Eccentric loading, Rankine's formula	11
5	**Thin Pressure Vessel:** Thin Pressure Vessels, Circumferential and longitudinal stresses in thin cylindrical shells and thin spherical shell under internal pressure **Thick Pressure Vessel**: Introduction, Lames Theorem, Thick Pressure vessels subjected to internal pressure, External Pressure & both, compound cylinders.	11
TOTAL HOURS (including Tutorials)		56

31. Brief description of tutorial activities

Tutorial classes are for application-based problem solving

32. Suggested texts and reference materials

1. **Text Books:**
   1. Mechanics of Material –). M. Gere and S. P. Timoshenko – CBS publisher
   2. Strength of Materials by Sadhu Singh.

Reference books:

1. An Introduction of mechanics of solid by Crandall, Dahl &Lardnee Tata McGraw Hill.
2. Advance Strength of Materials by L.S. Srinath
3. Mechanics of material by F.P. Beer & E.R. Johnson Jr. Tata McGraw Hil.
4. Engineering Mechanics of solids by Egor P. Popov., PHt
5. Introduction of solid mechanics by I. H. Shames
6. Elements of Strength of Material – S.P. Timoshenko & D.H. Young- AEWP

ME204TPE01 – MACHINE TOOL TECHNOLOGY

1.	**Department/Center proposing the course**	Mechanical Engineering
2.	**Course title**	**Machine Tool Technology**
3.	**L-T-P Structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	**ME204TPC08**
6.	**Status (Category for program)**	**Professional Elective-01**

7.	**Pre-requisites**	Knowledge of Workshop and Machine operations.

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Super cedes any existing course	No

9.	Not allowed for **(indicate program names)**	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **4th sem**

11.	**Faculty who will teach tbe course**	Expertise or specialization in the Manufacturing Engineering

12.	**Will the course require any visiting faculty**	No.

13.	**Course contents***(about 100 words) (include laboratory/design activities)*: Introduction to manufacturing and machining,Manufacturing need and concepts,Machining purpose principle and definition, Function of machine tool and machining requirements,

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	General purpose machine tools, mechanics, tools, geometry and	9

	chip formation, surface finish and machinability.	
2	Machine tool: Generation and machining principles, setting and operations on machines: lathe, milling, shaping, slotting, planning, drilling, boring, broaching, grinding, gear cutting.	8
3	Tooling: Jigs and Fixtures. principles of location, clamping, indexing and design of simple jigs and fixtures.	8
4	Batch production: NC Part programming. CNC machines, Finishing: Micro finishing, Introduction to 3D and 4D printing	8
5	Non-conventional machining: EDM, LBM, EBM, ECM, USM, AJM, Rapid prototyping	9
TOTAL HOURS		42

15. Brief description of tutorial activities

Tutorial classes are for application-based problem solving

16. Suggested texts and reference materials

Text Books and reference books:

1. Manufacturing technology (Vol.-I & II) by P.N. Rao Tata McGraw Hill Publishers.
2. Manufacturing Engg. And technology by S. Kalpakjian& S.R. Schmid, Addision Wesley Longman, New Delhi
3. Manufacturing science By A. Ghosh& A.K. Mallik East West Press Pvt. Ltd New Delhi
4. Manufacturing Process by O P Khanna Dhanpat Rai Publication
5. A Textbook of Production Engineering by Dr P C Sharma S Chand Publications
6. Metal Working Technology Narayanaswamy. R, , PHI

ME204TPE02 –MATERIAL SCIENCE & METALLURGY

1.	**Department/Center proposing the conrse**	Mechanical Engineering
2.	**Course title**	**Material Science & Metallurgy**
3.	**L-T-P Structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	**ME204TPC09**
6.	**Status (Category for program)**	**Professional Elective-02**

7.	**Pre-requisites**	Nil

8.	Status vis-à-vis other courses (Give Course number/title)	
8.1.	Overlap with any UG/PG course of the Dept./Centre	No
8.2.	Overlap with any UG/PG course of other Dept./Centre	No
8.3.	Super cedes any existing course	No

9.	Not allowed for **(indicate program names)**	

10.	Frequency of offering	☐ Every sem ☐ 1st Sem ☐ 2nd Sem ☐ Either Sem: **4th sem**

11.	**Faculty who will teach the course**	Expertise or specialization in the Materials, Design or Chemistry

12.	**Will the course require any visiting faculty**	No.

13.	**Course contents***(about 100 words) (include laboratory/design activities)*: Introduction and basic structure of materials, Mechanicalproperties of different materials,behavior of metals and alloys in different phases at different, application of materials.

14. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	Introduction and basic structure of materials, properties of materials , Material deformation and its control	9

2	Engineering Materials Metals,alloys,ceramics, polymers and their applications	8
3	Behavior of Metals and their properties in different Phase ,TTT Diagram, Heat Treatment processes	9
4	Mechanism of Corrosion and creep and there remedies	8
5	Advanced Engineering Materials composites, Nano Materials intermetallic, and biomedical materials and their applications	8
	TOTAL HOURS	42

15. Brief description of tutorial activities

NA

16. Suggested texts and reference materials

Text Books:

1. Material Science &Engg. – A first course – V. Raghavan – PHI (P) Ltd., Delhi,2003
2. A Text Book of Material Science & Science &Metallurgy,O.P. Khanna ,Dhanpat Rai & Sons, New Delhi

Reference Books:

1. Elements of Material Science &Engg. – Van Vlack. – Addison – Wesley Longman, 6th Edn., New York
2. Physical Metallurgy – Clark & Varney, East West Edn., New Delhi

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engineering
2.	**Course Title**	Fluid and Turbo Machinery
3.	**L-T-P structure**	3-1-0
4.	**Credits**	4
5.	**Course number**	**ME5TPC07**
6.	**Status** (*category* for *program*)	

7.	**Pre-requisites** (course no./title)	Thermodynamics, Fluid Mechanics
8.	**Status vis-à-vis other courses** *(give course number/title)*	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9		

10	**Frequency of offering**	Every sem☒ 1st sem☒ 2nd sem☒ Either sem☒
11	**Faculty who will teach the course**	
12	**Will the course require any visiting faculty?**	

13	**Course objective:** • The course aims at giving an overview of different types of fluid machines used for energy transformation, such as hydraulic and steam turbines, gas turbines, compressors, and pumps. • It focuses on applications in power generation, transport, refrigeration. • The main purpose of implementing this course in the curriculum is to learn about how the power is transferred in a turbomachine.

14	**Course contents:** **Unit-1** **Fundamentals:** Classification, Applications of turbomachines, Performance

parameters, Specific speed, Basic laws and equations, Velocity triangles.

Unit-2

Hydraulic turbines: Specific applications, types, construction, working, and performance of various types of hydraulic turbines (Pelton, Francis, and Kaplan turbines), Cavitation in turbines, and water hammer effects, Draft tube: Types, applications, and performance analysis.

Unit -3

Centrifugal pumps: Theory, types, components, and working characteristics, Cavitation, NPSH,Priming, Axial flow pumps, Practical problems, and remedies.

Unit-4

Thermal turbines: Steam turbine basic cycles, impulse and reaction turbines, Multistage turbines,Governing systems, Effects of reheating and regeneration, Application of Mollier diagram, Gas turbine basic cycle, Application of intercooling, reheating and regeneration, Introduction to wind turbines, Power and efficiency calculations.

Unit-5

Air compressors: Radial and axial compressors, Construction and performance analysis, Surging and stalling, Slip.

15. Lecture Outline *(with topics and number oflectures)*

Moduie no.	Topic	No. of hours
1.	Introduction to turbomachinery, Basic principles, Classification, Impulse and Reaction type, Fundamental equations, Euler's equation, Introduction to hydro-electric power plants, major components, Surge tanks, etc.	05
2.	Hydraulic Turbines: Classification of Turbine, Impulse Turbine, Pelton wheel, Construction and working, Work done, Head efficiency and Design aspects, Governing of Impulse turbine.	06
3.	Radial flow reaction turbine, Francis turbine: Construction and working, Work done, efficiency, Design aspect, Advantages and disadvantages over Pelton wheel.	05
4.	Propeller and Kaplan turbine, Bulb or Tubular turbine, Draft tube, Specific speed, Unit quantities, Cavitation, Degree of reaction, Performance characteristics, Surge tanks, Governing of Reaction turbine.	05
5.	Classification of Pumps, Centrifugal Pump, Construction, Working, Work Done, Heads, Efficiencies, Multistage Centrifugal Pump, Pump in Series and Parallel, Specific Speed, Characteristic, Net Positive Suction Head, Cavitation.	06
6.	Steam Turbines:Classification, Single-stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, Problems.Parson's turbine, condition for efficiency, reaction staging, Problems.	7
7.	Gas turbine: components, fuels, materials, Different cycle, analysis, Optimum pressure ratio for maximum specific output, the effect of modification on efficiency and output, Ideal and actual cycle.	05

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engineering
2.	**Course Title**	**INTERNAL COMBUSTION ENGINES**
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	**ME5TPC08**
6.	**Status** (*category* for *program*)	CORE

7.	**Pre-requisites** (course no./title)	Thermodynamics
8.	**Status vis-à-vis other courses** *(give course number/title)*	
8.1	Overlap with any UG/PG course of the Dept./Centre	No
8.2	Overlap with any UG/PG course of other Dept./Centre	No
8.3	Supercedes any existing course	No

9		

10	**Frequency of offering**	Every sem☒ 1st sem☒ 2nd sem☒ Either sem☒
11	**Faculty who will teach the course**	
12	**Will the course require any visiting faculty?**	**No**

13 Course objective:

- To familiarize with the terminology associated with IC engines.
- To understand the basics of IC engines.
- To understand combustion and various variables affecting it in various types of IC engines.
- To learn about various devices used in IC engines and the type of IC engine required for various applications.

Course Outcome:

- At the end of this course, the students will be able to understand the working of an I. C. Engines (i.e. S. I. and C. I. engine) and their appilcations.
- To understand the combustion process in I. C engines and different type's fuels, their stoichiometric compositions.
- To understand and identify various systems (ignition, injection, and cooling and lubrication system) of an I.C. Engine.

	• To understand and analyze the performance characteristics of an I. C engine and their emissions from of I. C. engines.

14	**Course contents**

Unit 1

Introduction of internal combustion engines: Engine classification, Air standard cycles, Otto cycle, Diesel cycle, Dual cycle, Comparison of Otto, Diesel, and Dual cycles. Stirling cycle, Ericsson cycles, Two and four-stroke engines, SI and CI engines, Valve timing diagram, Fuel air cycle, factors affecting it, Actual cycle analysis, Actual Cycle.

Unit 2

SI Engines - Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, Combustion chamber design for SI engines, Carburetion, Mixture requirements, Carburetor types, Theory of carburetor, MPFI, Ignition system requirements, Magneto and battery ignition systems, Ignition timing and sparkplug, Electronic ignition, Scavenging in 2 Stroke engines, Supercharging and its effect.

Unit 3

CI Engine - Combustion in CI engines, Ignition delay, Knock and it's control, Combustion chamber design of CI engines.

Fuel injection in CI engines, Requirements, Types of injection systems, Fuel pumps, Fuel injectors, Injection timings.

Unit 4

Engine Cooling - Different cooling systems, Radiators, and cooling fans.

Lubrication - Engine friction, Lubrication principle, Type of lubrication, Lubrication oils, Crankcase ventilation,

Fuels -Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas, Alternative fuels for IC engines.

Unit 5

Testing and Performance - Performance parameters, Basic measurements, Blow by measurement, Testing of SI, and CI engines.

Emission and Pollution: S. I. Engine and C. I. Engine emissions and its control and comparison. Effect of pollution on Human health and biosphere.

15. Lecture Outline *(with topics and number oflectures)*

Module no.	Topic	No. of hours
1	**Introduction to I.C Engines** - Engine classification, Air standard	09

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engineering
2.	**Course Title**	**Machine Design –I**
3.	**L-T-P structure**	4-0-0
4.	**Credits**	4
5.	**Course number**	ME05TPC09
6.	**Status** (*category* for *program*)	CORE

7.	**Pre-requisites** (course no./title)	Engg. Mechanics Mechanics of Solid-1
8.	**Status vis-à-vis other courses** *(give course number/title)*	
8.1	Overlap with any UG/PG course of the Dept./Centre	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NO

9.	**Not allowed for** (indicate program names)	
10.	**Frequency of offering**	EveryOdd Sem
11.	**Will the course require any visitlng faculty?**	NO
12.	**Courseobjective***(about50words)*: Provide students with the ability to apply design procedure with specificdesign tools representing empirical, semi-empirical and analytical approaches. Usinganalytical and computer aided design with real world problems.The detailed design of mechanical systems considers realistic examples from the mechanical Laboratories/workshop. Design a mechanical power transmission system given the power tobe transmitted, speed ratio, orientation and center distance of the shafts. Failure analysis, factor of safety, types of loading, selection of appropriate materials,lubrication, design for manufacturing, fits and tolerance will also be covered for the use in allthe above case based designs.	
13.	**Course Outcome:** At the end of this course, the students will be able to 1. Apply the various stress based theories to design machine components 2. Select appropriate design data from Design data book. 3. Design basic machine elements like Keys, joints, coupling and shafts. 4. Design and select power transmission systems- belt and chain drives. 5. Design various types of joints-threaded, riveted and welded.	

	6. Design different types of power screws- lead screw, screw jack and power screw.
14.	**Course contents** *(about 100 words) (Include laboratory/design activities)*: **UNIT – I General Considerations:** Selection of Materials, Design Stress, Factor of Safety, Stress concentration factor in tension, bending and torsion, Theories of failures. Notch sensitivity, Design for variable and repeated loadings, Fatigue stress concentration factor, Endurance diagrams, Introduction to fracture mechanics. **UNIT – II Basic Elements Design:** Types of keys and Splines, Design of Socket-Spigot, Cotter joint, Sleeve and Cotter joint, Gib and Cotter joint, Design of Knuckle joint, Design of Splines. **Couplings:** Types of couplings, Design of flange and flexible couplings, Compression coupling, Muff coupling. **Shaft and Axles:** Transmission shaft, Design against static load, Design for strength, Rigidity and stiffness, Design under continuous loading for fatigue. **UNIT- III Threaded fasteners:** Geometry of thread forms, Terminology of screw threads and thread standards, Specifications of steel bolts, Initial tension, Relation between bolt tension and torque, Design of statically loaded tension joints, Design of bolted joints due to eccentric loading. **Power Screws:** Power screws, Force analysis for square and trapezoidal threads, Collar friction, Stresses in screw, Coefficient of friction, Efficiency of thread, Design of power Screw. **UNIT – IV** **Riveted Joints:** Types of rivet heads, Types of riveted joints, Failure of riveted joint, Strength of rivet joint, Efficiency of riveted joint, Design of riveted joint, eccentrically loaded riveted joint. **Welded joint:** Types of welded joints, Stresses in butt and fillet welds, Strength of welded joints, Location and dimension of weld design, Eccentrically loaded joint, Welded joint subjected to bending moment, Design procedure, Fillet welds under varying loads, Stress relieving techniques. **UNIT – V Pulley & Flywheel:** Flywheel Inertia, Stresses in Flywheel and pulleys, failure criterion. **Chain Drives:** Chain drives, Roller chains, Geometric relationships, Dimensions of chain components, Polygonal effect, Power rating of roller chains, Selection of Chain drives. **Belt & Rope Drive:** Design of Flat and Round belt drives, V-Belt, Timing belt, Wire Rope.

15. Lecture Outline *(with topics and number oflectures)*

Module no.	Topic	No. of hours
1	Selection of Materials, Design Stress, Factor of Safety, Stress concentration factor in tension, bending and torsion, Theories of failures.	3
2	Notch sensitivity, Design for variable and repeated loadings, Fatigue stress concentration factor, Endurance diagrams, Introduction to fracture mechanics.	5
3	Types of keys and Splines, Design of Socket-Spigot,	3
4	Cotter joint, Sleeve and Cotter joint, Gib and Cotter joint, Design of Knuckle joint, Design of Splines.	4
5	Couplings , Shaft and Axles	4
6	Threaded Fasteners	4
7	Power Screw	2

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engineering
2.	**Course Title**	Mechanics of Solid-II
3.	**L-T-P structure**	3-1-0
4.	**Credits**	4
5.	**Course number**	ME05TPC10
6.	**Status** (*category* for *program*)	CORE

7.	**Pre-requisites** (course no./title)	Engg. Mechanics Mechanics of Solid-1
8.	**Status vis-à-vis other courses** *(give course number/title)*	
8.1	Overlap with any UG/PG course of the Dept./Centre	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NO

9.	**Not allowed for** (indicate program names)	
10.	**Frequency of offering**	☐ Every sem ☐ 1st sem ☐ 2nd sem ☒ Either sem
11.	**Will the course require any visiting faculty?**	NO
12.	**Course objective** *(about 50 words)*: Mechanical behaviour of the body by determining the stresses, strains and deflections produced by the different types of loads and couple. Fundamental concepts related to deformation, strain energy, moment of inertia, and load carrying capacity, slope and deflection of beams, shear forces, bending moments, torsional moments, column and struts, principal stresses and strains and theories of failure.	
13.	**Course Outcome:** At the end of this course, the students will be able to 1. Visualize and apply mathematics to obtain analytical solutions in solid mechanics. 2. Interpret the principle of superposition, energy methods of determining the reaction and their applications for solving statically indeterminate structures. 3. Apply the basic concepts of stress and strain in dealing problems related to	

	unsymmetrical bending, fixed beams, continuous beams, curved beams, thick and thin pressure vessels. 4. Discover principles of solid mechanics by solving engineering problems. 5. Develop appropriate models for practical situations to formulate solutions.
14.	**Course contents** *(about 100 words) (Include laboratory/design activities)*: **UNIT - I Energy Methods**: Introduction, Principles of superposition, Strain energy, Reciprocal relations, Maxwell Betti theorem, Elastic strain energy in tension and compression, Strain energy in beams subjected to bending and shafts to torsion. Impact loading in tension and bending, first and second theorem of Castigliano and its applications. **UNIT - II Fixed Beams:** Fixed beam subjected to different types of loads and couples, Calculations of fixing moments and reactions at supports, deflection. Effect of sinking of support. **Continuous beams**: Continuous beams subjected to different type of loads and couples, beams with overhang, beams with one end fixed, Clapeyron's theorem. Effect of sinking of supports. **UNIT – III Bending of curved bars:** Stresses in bars of small initial curvature, Winkler-Bach theory, Stresses in bars of large initial curvature, Deflection of Crane hooks, Chain links, circular rings, stresses in circular rings. **UNIT – IV Unsymmetrical Bending:** Introduction to unsymmetrical bending, Stresses and deflection in unsymmetrical bending, Shear center for angle, Channel and I-sections. **Columns:** Struts and Columns, Stability of columns, Euler's formula for different end conditions,, Equivalent load, Eccentric loading, Rankine's formula. **UNIT – V Thin Pressure Vessel:** Thin Pressure Vessels, Circumferential and longitudinal stresses in thin cylindrical shells and thin spherical shell under internal pressure, **Thick Pressure Vessel:** Stresses in thick and compound cylinders.

15. Lecture Outline *(with topics and number oflectures)*

S. No.	Topic	No. of hours
1	Introduction, Principles of superposition, Strain energy	2
2	Reciprocal relations, Maxwell Betti theorem	2
3	Elastic strain energy in tension and compression	2
4	Strain energy in beams subjected to bending and shafts to torsion.	2
5	Impact loading in tension and bending, first and second theorem of Castigliano and its applications	2
6	Fixed Beams	4
7	Continuous Beams	4
8	Bending of Curved Beams	5
9	Unsymmetrical Bending	5
10	Columns	2
11	Thin Pressure Vessel	4
12	Thick Pressure Vessel	4
	COURSE TOTAL	38

COURSE
TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engg
2.	**Course Title**	Computer Aided Design & Manufacturing (CAD-CAM)
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ME06TPE23
6.	**Status** (*category* for *program*)	Professional Eleetive

7.	**Pre-requisites** (course no./title)	Engineering Graphics Machine Drawing

8.	**Status vis-à-vis otber courses** *(give course number/title)*	
8.1	Overlap with any UG/PG course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	Nil
8.3	Supercedes any existing course	No

9.	**Not allowed for** (indicate program names)	
10.	**Frequency of offering**	Every even semesters
11.	**Will the course require any visiting faculty?**	No

12. Course objective *(about 50 words)*:

- To introduce the student to CAD terminology & its capabilities.
- To become familiar with CAD software, Graphical user interface & basic tools.
- To recognize geometric and graphical elements of engineering design problems
- To apply a "hands-on" understanding of the basic concepts of computer-aided manufacturing and prototyping through group and individual projects.

13. Course Outcome

Upon completing the course, the student will be able to:

1. Perceive the concepts of CAD/CAM as well as be able to model analytic and synthetic curves, surfaces and solid models.
2. Compile the NC system and various part programming techniques.
3. Demonstrate group technology and data base management system.
4. Acquire the concepts of design and synthesis of planer mechanisms using computer based applications.

14. Course content

Basics of CAD: Basics fundamental of Computer Graphics, Principle of computer graphics, Product life cycle, Concept of Computer Aided Design (CAD) and architecture, Hardware and software, Color management, Raster graphics, Graphics standard, Graphic primitives,

lines, and Circle Drawing algorithms, Software documentations, CAD standards GKS, OpenGL, Data exchange standards- IGES, STEP, CALS etc, Communication standards. Standards for vexchange images.

Geometric Modeling of Curves, Surface and Solid: Basics representation of curves, Parametric and nonparametric curves, Mathematical representation of curves, Hermite curves, Bezier curves, B-spline curves and rational curves. Basic of Surface, Techniques of surface modelling, Plane surface, Rule surface, Surface of revolution and sweep, Coons and bi-cubic patches, concept of Bezier and B-spline surfaces, Basic concept of solid modelling technique, CSG and B-rep method for solid generation.

Geometric Transformation: Computer Aided Design (CAD) methodology, Coordinate systems, Theory and applications, 2D and 3D geometric transformation, Homogeneous transformation, Concatenation, Assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, Visual realism- hidden line-surface-solid removal algorithms, shading, coloring, computer animation, Concurrent Engineering.

Basics of CAM: Basic concept of numerical control (NC) System, NC coordinate system, NC motion control, Application of NC, concepts of computer numeric control(CNC) system, problems with conventional, NC, CNC.

Part Programming: Introduction to NC part programming, manual part programming, Computer assisted part programming, Automatically Programming Tool (APT) language, statements and code of APT, programming methods, advantages of CAD/CAM programming.

15. Lecture Outline *(with topics and number of lectures)*

S.No	Topic	No. of hours
1	**Basics of CAD**	7
2	Basics representation of curves, Parametric and nonparametric curves, Mathematical representation of curves, Hermite curves, Bezier curves, B-spline curves and rational curves.	6
3	Basic of Surface, Techniques of surface modelling, Plane surface, Rule surface, Surface of revolution and sweep, Coons and bi-cubic patches, concept of Bezier and B-spline surfaces	6
4	Basic concept of solid modelling technique, CSG and B-rep method for solid generation.	5
5	Computer Aided Design (CAD) methodology, Coordinate systems, Theory and applications, 2D and 3D geometric transformation, Homogeneous transformation, Concatenation,	5
6	Assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, Visual realism- hidden line-surface-solid removal algorithms, shading, coloring, computer animation, Concurrent Engineering.	6
7	Basics of CAM	5
8	Part Programming	5
	COURSE TOTAL	45

16. Brief description of tutorial activities

A

17. Brief description of laboratory activities

Course Template

1.	**Department/Center proposing tbe course**	Mechanical Engineering
2.	**Course title**	**Heat & Mass Transfer**
3.	**L-T-P Structure**	3-1-0
4.	**Credits**	4
5.	**Course number**	ME06TPC11
6.	**Status (Category for program)**	Program Core

7.	**Pre-requisites**	Engineering Thermodynamics, Fluid Mechanics, Basics of Electrical Circuits (Ohm's Law)

7.1.	Overlap with any UG/PG course of the Dept./Centre	No
7.2.	Overlap with any UG/PG course of other Dept./Centre	Yes, Industrial & Production Engineering (IP6TPE53), Chemieal Engineering (**CHPG1101, CH5TPC06**)
7.3.	Super cedes any existing course	No

8.	Not allowed for **(indicate program names)**	

9.	Frequency of offering	Odd Semester
10.	**Faculty who can teacb the course**	Fluid-Thermal Group

11.	**Will the course require any visiting faculty**	No

12.	**Course objectives** *(about 50 words):* • To introduce students to fundamentals of heat and mass transfer processes with adequate application examples

13.	**Course outcomes** *(about 50 words):* • Graduates shall be able to apply, analyze and solve elementary problems of engineering interest involving heat transfer mechanisms

14.	**Course contents***(about 100 words) (include laboratory/design activities)*: • **Module-1**: Introduction to modes and mechanisms of heat transfer, Fourier's law, Electrical analogy, Overall heat transfer coefficient, Conduetion heat transfer in rectangular, cylindrical and spherical solids, 1-D steady state heat transfer with & without heat generation, critical radius of insulation, Unified view of momentum, heat and mass transfer • **Module-2:** 1-D steady state heat conduction in Extended surfaces, Lumped Capacitance and 1-D transient models, Semi-infinite wall, Error in Temperature measurement, Diffusion mass transfer in 1-D steady state • **Module-3:** Convection: Forced and free convection - mass, momentum and energy conservation equations, scaling analysis and significance of non-dimensional numbers, velocity & thermal boundary layers, heat transfer in external and internal laminar and turbulent flows, and use of correlations, • **Module-4**: Convective mass transfer; Boiling and Condensation: physical phenomena and correlations; Heat Exchanger types and analysis: LMTD and Effectiveness-NTU method • **Module-5**: Radiation heat transfer: Properties, laws, configuration factors, radiation shields, three-surface network of diffuse gray surfaces

15. **Lecture outline***(with topics and number of lectures)*

Module No.	Topics	No. of hours
1	General Introduction: One dimensional	10
	Heat conduction; Introduction to mass transfer	
2	Introduction to extended surfaces	7
	1-D transient heat conduction analysis	
3	Velocity and thermal boundary layer concepts	12
	Forced and Free convection, correlations	

COURSETEMPLATE

1.	**Department/Centreproposingthecourse**	Mechanical Engineering
2.	**CourseTitle**(<45characters)	**MANUFACTURING SCIENCE-II**
3.	**L-T-Pstructure**	3-0-0
4.	**Credits**	3
5.	**Coursenumber**	**ME6TPC12**
6.	**Status** (categoryforprogram)	CORE

7.	**Prerequisites**(course no./title)	Knowledge of Workshop and Machine Operations
8.	**Statusvis-à-visothercourses**(givecoursenumber/title)	
8.1	Overlap with anyUG/PGcourseof theDept./Centre	No
8.2	Overlap with anyUG/PGcourseof other Dept./Centre	No
8.3	Supercedesany existingcourse	No

10.	**Frequencyofoffering**	☐ Every sem ☐ I st sem ☐ 2nd sem ☐ 6th sem
11.	**FacultywhowillteachthecourseMr. Manish Bhaskar**	
12.	**Willthecourserequireanyvisitingfaculty ?**	No
13.	**Courseobjective**(about50words):	

1. To understand grinding and other surface finishing operations.
2. To understand the design considerations of Jigs and Fixtures.
3. To understand various non-conventional machining processes and their applications.
4. To understand the process of Gear Shaping and Gear Hobbing.

14. **Coursecontents**(about100words)(Includelaboratory/designactivities):

Unit-I

General purpose machine tools: Constructional details of lathe, drilling, milling, shaping, planning machines. Tooling, attachment and operation performed, selection of cutting parameters, calculation of forces and time for machining. Broaching operation. Capston and turret lathes, single and multiple spindle automates, operation planning and tool layout.

Jigs and Fixtures; Degree of freedom, principles of location and clamping, locating,clamping and indexing devices, principles of design, design of simple jigs and fixtures.

Unit-II

Mechanics of metal cutting: Classification of metal removal process and machines, geometry of single point cutting tool and tool angles. Tool nomenclature in ASA, ORS& NRS and interrelationship. Mechanism of chip formation and types of chips, chip brakers. Orthogonal and oblique cutting. Cutting forces and power required, theories of metal cutting, thermal aspects of machining and measurement of chip tool interface temperature. Friction in metal cutting.

Unit-III

Machinability: Concept & evaluation of Machinability, tool life and mechanisms of toolfailure, cutting parameter, Machinability index, factors effecting Machinability. Cutting Fluids-Types, selection and application methods. Cutting tool material-Requirement of tool material, classification of tool material and their properties.

Unit-IV

Grinding Processes & Gear Cutting: Abrasives: natural and synthetic, Manufacturingnomenclature, Selection of grinding wheels, wheel mounting and dressing ,surface and cylindrical grinding, their constructional detail and processes. Principle of gear generation, gear cutting by milling machines, gear shaping and gear hobbing machines processes.

Unit-V

Non-Conventional Machining: Mechanism of material removal, tooling and equipment, process parameter, surface finishing obtained by EDM, LBM, EBM, ECM, USM, AJM processes, benefits, generation application and survey of non-conventional machining process.

COURSE TEMPLATE

1.	**Department/Centreproposingthecourse**	Mechanical Engineering
2.	**CourseTitle**(<45characters)	**MEASUREMENT, METROLOGY AND CONTROL**
3.	**L-T-Pstructure**	3-0-0
4.	**Credits**	3
5.	**Coursenumber**	**ME6TPE31**
6.	**Status** (categoryforprogram)	Theory (Professional Elective)

7.	**Prerequisites**(courseno./title)	Knowledge of Measuring instruments and Scale
8.	**Statusvis-à-visothercourses**(givecoursenumber/title)	
8.	Overlap with anyUG/PGcourseof theDept./Centre	No
8.	Overlap with anyUG/PGcourseof other Dept./Centre	No
8.	Supercedesany existingcourse	No

10.	**Frequencyofoffering**	☐ Every sem ☐ 1st sem ☐ 2nd sem ☐ 6th sem
11.	**FacultywhowillteachthecourseMr. Manish Bhaskar**	
12.	**Willthecourserequireanyvisitingfaculty?**	No
13.	**Courseobjective**(about50words): 5. To understand the concepts in measurement and metrology. 6. To be familiar with different sensors and transducers. 7. To build suitable measurement technique. 8. To have the confidence to apply automation solutions for given industrial applications. 9. To demonstrate the ability to design and conduct experiments, interpret and analyze data, and report results.	

4. **Coursecontents**(about100words)(Includelaboratory/designactivities):

UNIT-I

Introduction to Measurement and Measuring Instruments: Generalized Measuring Systems and Functional Element, Static & Dynamic Performance Characteristic of Measurement Devices, Calibration, Concept of Error, Sources of Error, and Analysis of Error. Transducers: Types of Transducers and Their Characteristics, Measurement of Strain, Strain Gauges and Their Working, Gauge Factor, Strain Gauge Circuits, Strain Rosettes.

UNIT-II

Measurement of Pressure: Pressure Measuring Transducers, Elastic Diaphragms, Measurement of Vacuum and Low Pressure, Various Low Pressure Gauges. Measurement of Fluid Flow: Various Methods of Flow Measurement and Devices Temperature Measurement: Bi-Metallic Thermometers, Thermocouples, Thermistors and Pyrometers.

UNIT-III

Metrology :Standards of Linear Measurement ,Line and End Standards System of Limit and Fits, Limit Gauges and Their Design, Measurement of Geometric Forms Like Straightness, Flatness, Roundness and Circularity ,Measurement of Surface Textures, Quantitative Evaluation of Surface Roughness and Its Measurement, Introduction of CMM, Its Working and Application.

UNIT-IV

Interferometry: Principle and Uses of Interferometry, Types of Interferometers Comparators: Classification, Working Principle and Magnification Range of Mechanical, Electrical, Optical, Electronic, Pneumatic Comparators, Measurement of Screw Threads & Gears, Two Wire and Three Wire Method

UNIT-V

Fundamentals of Control System: Control system concepts, classification of control systems, mathematical representation of system equations, hydraulic, pneumatic, thermal and mechanical system and their mathematical modelling, response characteristics of components and systems through classical solution.

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engineering
2.	**Course Title**	Operations Research
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ME06TOE13
6.	**Status** (*category* for *program*)	Open Elective

7.	**Pre-requisites** (course no./title)	

8.	**Status vis-à-vis other courses** *(give course number/title)*	
8.1	Overlap with any UG/PG course of the Dept./Centre	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NO

9.	**Not allowed for** (indicate program names)	☐ ☐ ☐
10.	**Frequency of offering**	Every sem 1st sem 2nd sem ☒Either sem
11.	**Will the course require any visiting faculty?**	NO
12.	**Course objective** *(about 50 words)*: Knowledge and understanding - Be able to understand the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type. Cognitive skills (thinking and analysis) - Be able to build and solve Transportation Models and Assignment Models. Communication skills (personal and academic). - Be able to design new simple models, like: CPM, MSPT to improve decision – making and develop critical thinking and objective analysis of decision problems. Practical and subject specific skills (Transferable Skills). - Be able to implement practical cases, by using TORA, WinQSB.	
13.	**Course Outcome** At the end of this course, the students will be able to	

	1. Visualize and apply mathematics to obtain analytical solutions in solid mechanics. 2. Interpret the principle of superposition, energy methods of determining the reaction and their applications for solving statically indeterminate structures. 3. Apply the basic concepts of stress and strain in dealing problems related to unsymmetrical bending, fixed beams, continuous beams, curved beams, thick and thin pressure vessels.. 4. Discover principles of solid mechanics by solving engineering problems. 5. Develop appropriate models for practical situations to formulate solutions.
14.	**Course contents** *(about 100 words) (Include laboratory/design activities)*: **UNIT I** Introduction to linear programming: Graphically solution to linear programming problem, solving linear problem by simplex method, optimization problem, maximization & minimization function with or without constraints, sack surplus & artificial, variable method, degeneracy problem. **UNITII** Mathematical statement of the transportation problem: The transportation model, method for basic feasible solution, Degeneracy & unbalance problem, Mathematical statement of the assignment problem, solution of assignment problem, travelling sales-man problem. **UNIT III** Game theory: Rule of game, Method of solving game , graphically & Arithmetic , saddle point &without saddle point , dominance method, mixed strategies 2 X 2game , 2 X N game , M X 2 game , 3 X 3game (Method of matrix's, method of linear programming etc). Inventory: Introduction, classification, function, level, control techniques, models, and various costs associated, EOQ, optimum lot sizing. **UNITIV** Introduction of queuing theory: Elements of queuing system ,operating characteristics of a queuing system, Poisson arrivals & exponential service time , waiting time & idle time cost, single channel queuing theory. Replacement problems: Requirement policy, replacement of items, machinery various themes, group replacement policy, MAPI methods. **UNITV** Network analysis: Introduction of PERT & CPM, computation of PERT, Time estimation, measure of deviation &variation, probability of completing project, Arrow diagram &critical path method, Scheduling, cost analysis & crushing of network.

15. Lecture Outline *(with topics and number oflectures)*

S. No.	Topic	No. of hours
1	Linear Programming, Graphical solution	3
2	Simplex method, Optimization Problem	4
3	Transportation problem	5
4	Assignment problem	4
5	Game theory: Rule of game, Method of solving game , graphically &	3

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Mechanical Engineering
2.	**Course Title**	**Machine Design- II**
3.	**L-T-P structure**	4-0-0
4.	**Credits**	4
5.	**Course number**	ME06TOE21
6.	**Status**(*category* for *program*)	OPEN ELECTIVE

7.	**Pre-requisites** (course no./title)	Machine Design -I Mechanics Of Solids-I Engineering Mechanics	
8.	**Status vis-à-vis otber courses** *(give course number/title)*		
8.1	Overlap with any UG/PG course of the Dept./Centre		Nil
8.2	Overlap with any UG/PG course of other Dept./Centre		Nil
8.3	Supercedes any existing course		No

9.	**Not allowed for** (indicate program names)	
10.	**Frequency of offering**	Every even semesters
11.	**Will the course require any visiting faculty?**	No
12.	**CourseObjective***(about50words)*: To apply the concepts of stress analysis, theories of failure and material science toanalyse, design and/or select commonly used machine components. To illustrate to students the variety of mechanical components available and emphasizethe need to continue learning. To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly usedmechanical systems.	
13.	**Course Outcomes:** At the end of this course, students will be able to Design springs under static and fluctuating loading conditions Design brakes and clutches Perform design and selection of transmission elements Design and suggest selection of bearings.	
14.	**Course content** **UNIT-I:** **Springs**: Spring Materials and Their Mechanical Properties, Equation for Stress AndDeflection, Helical Coil Springs of Circular Section for Tension, Compression and Torsion, Dynamic Loading, Fatigue Loading, Wahl Line, Leaf Spring and Laminated Spring. **UNIT-II:**	

Subject: **Advanced Mechanics of Solids (MEPATT1)**

		Credits			
		L	T	P	Total
Type:	Programme Core				
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Analyse state of stresses and strains in a 3-D continuum

2 Establish stress-strain relations for deformable solids

3 Apply energy methods to deformable solids

4 Evaluate stresses in symmetrical and asymmetrical beams

5 Analyse thin wall beams, torsional bars and axisymmetric problems

Syllabus Contents:

Module 1: Analysis of Stress: Introduction, Body Force, surface force and stress tensor, The state of stress at a point, Normal, Shear and Rectangular stress components, Stress components on an arbitrary plane, Equality of cross shears, A more general theorem, Principal stresses, Stress invariants, Principal planes, cubic equations, The state of stress referred to principal axes, Mohr's circles for the 3-D state of stress, Octahedral stresses, the state of pure shear, Lame's Ellipsoid, The plane state of stress, Differential equations of equilibrium, Equations of equilibrium in cylindrical coordinates, Axisymmetric case and plane stress case.

Module 2: Analysis of Strain: Introduction, Deformations in the neighborhood of a point, Change in length of a linear element, Change in length of a linear element-linear components, The state of strain at a point, Interpretation of shear strain components, Cubical dilatation, angle between two line elements, Principal axes of strain and principal strains, Plane state of strain, Plane strains in polar coordinates, Compatibility conditions.

Module 3: Stress-Strain Relations for Linearly Elastic Solids: Introduction, generalized statement of Hooke's law, Stress-strain relations for isotropic materials, Modulus of rigidity, bulk modulus, Young's modulus and poison's ratio, Relation between the elastic constants, Displacement equations of equilibrium.

Module 4: Energy Methods: Hooke's law and the principle of superposition, Work done by forces and elastic strain energy, Maxwell-Betti-Rayleigh Reciprocal theorem, First and second theorem of Castigliano, expressions for strain energy when an elastic member is subjected to axial force, Shear force, Bending moment and Torsion. Theorem of virtual work, Kirchhoff's theorem. Bending of Beams: Straight beams and asymmetrical bending, shear center or center of flexure, shear stresses in thin walled open sections: Bending of curved beams (Winkler –Bach formula).

Module 5: Torsion: Torsion of general prismatic bars-solid sections, Torsion of circular, elliptical, triangular bars, Torsion of thin walled tubes and multiple closed sections, center of twist and flexure center.Axi-symmetric Problems: Thick walled cylinder subjected to internal and external pressures-Lames-problems, sphere with purely radial displacements, rotating disc of uniform thickness, rotating shafts and cylinders.

References:

- L.S. Srinath, Advanced Mechanics of Solids, 3rd Edition, TMH, 2009
- Crandall, S.H.,Dall N.C.and Lardner T.J.,An Introduction to Mechanics of Solids, McGraw-Hill
- Irving H. Shames, Mechanics of Deformable Solids, Krieger Pub Co, 2008
- Boresi,A.P.,and Sidebottom, O.M., Advance Mechanics of Materials, John Willey and sons
- Clive L. Dym and Shames I.H., Solid Mechanics: A Variational Approach, Engineering Science Series

Subject: **Advanced Computer Aided Design (MEPATT2)**

		Credits			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Apply geometric transformations and projection metbods in CAD

2 Develop geometric models to represent curves

3 Design surface models for engineering design

4 Model engineering components using solid modelling techniques for design

5 Analyze the solid model and able to calculate its property through basic fundamental of FEM

Syllabus Contents:

Module-I: Introduction: Introduction to CAE. CAD. Role of CAD in Mechanical Engineering. Design process, software tools for CAD, Geometric modelling. Introduction to Geometric Modeling for Design: Introduction to CAGD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

Module-II: Transformations in Geometric Modeling: Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Computer-Aided assembly of rigid bodies, Applications of transformations in design and analysis of mechanisms, etc. Implementation of the transformations using computer codes.

Module-III: Projections: Projective geometry, transformation matrices for Perspective, Axonometric projections, Orthographic and Oblique projections. Implementation of the projection formulations using computer codes. Basics of curves, parametric and non-parametric curves, analytical and synthetic curves, parametric representation of analytical and synthetic curves, Hermite curves, curve manipulations, Bèzier curves, B-splines, rational curves, wire frame models.

Module-IV: Surfaces in Geometric Modeling for Design: Differential geometry of surfaces, Parametric representation, Curvatures, Developable surfaces. Surfaces entities (planar, surfac of revolution, lofted etc). Free-for surface models (Hermite, Bezier, B-spline surface). Boundary interpolating surfaces (Coon's). Implementation of the all the surface models using computer codes.

Module-V: Solids in Geometric Modeling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling, Popular modeling methods in CAD softwares. Data Exchange Formats and CAD Applications; analytic solid modeling (ASM), introduction to finite element method (FEM), 1-D FEM analysis.

References:

- Zeid I. & Subramanian R. S., CAD/CAM Theory and practice, Tata McGraw Hill.
- Michael E. Mortenson, Geometric Modeling, Tata McGraw Hill, 2013
- A. Saxena and B. Sahay, Computer-Aided Engineering Design, Anamaya Publishers, New Delhi, 2005
- Rogers, David F., An introduction to NURBS: with historical perspective, Morgan Kaufmann Publishers, USA, 2001
- David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008
- Newman W.M.&SproullR.F.,Principles of Interactive Computer Graphics,Tata McGraw Hill.
- Groover M.P. &Zimmers E.,CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education

Subject:	**Mechanics of Composite Materials (MEPATP)**	**Credits**			
Type:	ProgrammeElective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the characteristics of composite materials

2 Select suitable manufacturing processes to develop fiber reinforced composites.

3 Analyze the micro and macro mechanical bebavior of fiber reinforced composites

4 Develop tbe governing equations for bending, buckling and vibration of laminated plates

5 Design the composite structures for engineering applications

Syllabus Contents:

Module-I: Introduction to composite materials: Classification and characteristics of composite materials, Mechanical behavior of composite materials, Basic terminology of laminated fiber reinforced composite materials, Manufacturing of laminated fiber reinforced composite materials.

Module-II: Techniques for composites manufacturing: Hand laminating (or Wet Lay-up) and the Autoclave processing of composites, Filament winding and fiber placement, Pultrusion, Liquid composite molding.

Module-III: Micromechanical behavior of lamina: Stress-strain relation for anisotropic materials, Stiffness, Compliances, Engineering constants, Restriction on Engineering constants, Stress- strain relation for plane stress in orthotropic materials.

Module-IV: Macro mechanical behavior of laminates and plate theories: Elastic approach to stiffness, Mechanics of materials approach to stiffness, Mechanics of materials approach to strength, Classical laminate theory, Special cases of laminate stiffness, Strength of laminates, Inter laminar stresses, Axisymmetric shells.

Module-V: Bending, Buckling, and Vibration of Laminated Composites: Governing equations for Bending, Buckling, and Vibration of laminated plates, Deflection of simply supported laminated composites.

References:

- Ronald F. Gibson, Principles of composite material mechanics, CRC Press, 2011
- Robert M Jones, Mechanics of Composite Materials, Taylor & Francis, 2000
- Lawrence E. Nielsen, Nielson, Paul Nielsen, Mechanical Properties of Polymers and Composites, Second Edition, CRC press, 2000

Subject: **Advanced Engineering Materials (MEPATP)**

		Credits			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the bonding and atomic structure of solids

2 Identify and draw the phase diagrams

3 Analyze the types of failure of solids

4 Apply the principles of heat treatment processes of materials

Syllabus Contents:

Module-I: Introduction, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids: Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, Atomic structure. Atomic bonding in solids, Crystal structures. Crystalline and noncrystalline materials. Miller indices. Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers.

Module-II: Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms: Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations. Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves. Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice resistance to dislocation motion.

Module-III: Phase Diagrams Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system. Failure: Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects

Module-IV: Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites: Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing. Particle reinforced composites. Fibre reinforced composites. Structural composites. Introduction to Functionally Graded materials

Module-V: Electrical, Thermal, Optical and Magnetic Properties and economic Considerations: Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behaviour. Ferro electricity. Piezoelectricity Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Para magnetism. Ferromagnetism, Antiferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour. Domains and Hysteresis, Basic concepts. Optical properties of metals. Optical properties of non-metals. Application of optical phenomena. Economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design

References:

- William D. Callister, Jr, Materials Science and Engineering, John Wiley & sons
- Smallman R.E., Bishop R J, Butterworth Heinemann, Modern Physical Metallurgy and Material Engineering Science, Process, application, Sixth Ed., 1999

Subject: **Design for Manufacturing and Assembly (MEPATP)**

		Credits			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the quality aspects of design for manufacture and assembly

2 Apply Boothroyd method of DFM for product design and assembly

3 Apply the concept of DFM for casting, welding, forming and assembly

4 Identify the design factors and processes as per customer specifications

5 Apply the DFM method for a given product

Syllabus Contents:

Module-I: Introduction to DFM, DFMA: Working of DFMA, Reasons for Not Implementing DFMA, Advantages of Applying DFMA during Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Module-II: Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

Module-III: High speed Automatic Assembly & Robot Assembly: Design of Parts for High-Speed Feeding and Orienting, Additional Feeding Difficulties, High-Speed Automatic Insertion, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

Module-IV: Design for Machining and Injection Molding: Cost Estimating for Machined Components, Injection Molding Materials, Estimation of the Optimum Number of Cavities, Design Guidelines. Design for Sheet Metal working & Die Casting: Turret Press working, Press Brake Operations, Design Rules, Design Principles.

Module-V: Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

References:

- Geoffrey Boothroyd, Assembly Automation and Product Design, Marcel Dekker Inc., NY, 3rd Edition,2010
- Geoffrey Boothroyd, Hand Book of Product Design, Marcel Dekker Inc., NY, 1992

Subject:	**Mechanical Vibrations (MEPATP)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Exemplify and summarise the causes and effects of vibration in mechanical systems and identify discrete and continuous systems

2 Model the physical systems in to schematic models and formulate the governing equations of motion

3 Infer the role of damping, stiffness and inertia in vibratory systems

4 Analyze the Rotating/reciprocating systems and compute the critical speeds

5 Analyze and design machine supporting structures, Vibration Isolators, Vibration Absorbers

Syllabus Contents:

Module-I: Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models.SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method; Free Vibration: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation.

Module-II: Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration

Module-III: Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion; Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers.

Module-IV: Multi degree of freedom systems: Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.

Module-V: Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method.

References:

- S.S.Rao, "Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
- L.Meirovitch, "Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985
- W.T. Thompson, Theory of Vibration,. CBS Publishers
- Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

Subject: **Advanced Mecbanical Design (MEPATP)**

		Credits			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will he able to**

1 Design mechanical components by selecting a suitable material and failure criteria

2 Evaluate fatigue life of mechanical components for ductile and brittle materials

3 Analyze and predict the fracture strength of mechanical components under different fracture modes

4 Design mechanical components involving contacts avoiding the surface failures

Syliabus Contents:

INTRODUCTION

Module-I: Material selection for design: Engineering Design process and the role of materials; materials classification and their properties; Materials Selection, Examples of material selection for typical applications, Elasticity, Plasticity, Bauschinger effect.

Module-II: Review of fundamental concepts: Overview of mechanical design, Free body diagram, Load analysis - 2D and 3D static load analysis, Case studies of static load analysis - Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench, Cyclic loading, Impact loading, Beam loading. Understanding of static failure for ductile and brittle materials, Comparison of experimental data with failure theories, Significance of the theories of failure, importance of factor of safety in design, Design case studies - Bracket, Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench.

Module-III: Fatigue Failure theories: Introduction to fatigue, Fatigue failure models, Fatigue life, Estimation of theoretical fatigue strength, Correction factors to the theoretical fatigue strength, stress concentration, Cumulative damage and life exhaustion, effect of mean stress, Designing for fully reversed uniaxial stresses, Designing for fluctuating uniaxial stresses, Designing for multi-axial stresses in fatigue.

Module-IV: Introduction to Fracture and Creep: Fundamentals of Fracture mechanics, Mechanism of fracture - Cleavage fracture, Ductile fracture and Inter-granular fracture, Linear Elastic Fracture Mechanics (LEFM) - Crack propagation with plasticity, hypothesis of LEFM, stress field in an isotropic material in the vicinity of crack tip, Elasto Plastic Fracture Mechanics (EPFM), Creep mechanisms, temperature dependence of creep

Module-V: Design for failure prevention: Fracture mechanics in Design, Design case studies - Bicycle with pedal arm, Plier-wrench. Surface failures - Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue wear, Contacts - Spherical contact, Cylindrical contact and General contact, Failure modes and effects analysis (FMEA).

References:

- Robert L Norton, Machine design an integrated approach, Pearson Education, Second edition, 2009
- Richard G. Budynas, J Keith Nisbett, Shigley's Mechanical Engineering Design, Mc Graw Hill, Ninth edition, 2011
- Marc Meyers and Krishan Chawla, Mechanical Behavior of materials, Cambridge University Press, 2nd Edition, 2009
- Wolé Soboyejo, Mechanical properties of engineered materials, Mareel Dekker, Inc., 2002
- Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education (India) Private Limited, 2014

Subject: **Numericai Simuiation Lab (MEPAPT1)**

		Credits			
Type:	ProgrammeCore	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	I	0	2	2

Course outcomes: **At the end of the course, students will be able to**

1 Understand numerical techniques using MATLAB/SCILAB

2 Formulate and solve problems using numerical methods

3 Build 2D and 3D representation of objects using CAD software

4 Design surfaces and solids as per geometrical requirements

Syliabus Contents:

- To know the history and features of MATLAB & the local environment of MATLAB
- Write a program to find the roots of an equation using Bi-section method, Regula-falsi method and Newton Raphson method
- Find the addition, subtraction, multiplication, transpose and inverse of matrices
- Find the area enclosed between the curves in MATLAB/SCILAB
- Find the derivative of an equation in MATLAB/SCILAB
- Find the roots of equations, find the values at different points and plot the graph
- Plot the surface for an equation
- Introduction to CAD software and working with features like Extrude & Revolve in sketch mode
- 3D modeling of different components using CAD software
- Assembly modelling in CAD software: Generating, editing and modifying drawings
- Surface modeling of different mechanical components in CAD software
- Presenting different orthographic/isometric views of 3D models in CAD software

References:

- Lab Instruction Manual

Subject:	**Research Methodology & iPR (IPPATC1)**	**Credits**			
Type:	MANDATORY COURSE	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will he able to**

1 Understand research problem formulation

2 Analyze research related information

3 Follow research ethics

4 Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property

5 Right to be promoted among students in general & engineering in particular

Syliabus Contents:

Module-I: Introduction and Design of research: Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

Module-II: Data and Methods of Data Collection Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability

Module-III: Data Analysis: Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution, analysis of variance: one way, two way, chi square test and its application, students 'T' distribution, non-parametric statistical techniques, binomial test. Correlation and regression analysis – discriminate analysis – factor analysis – cluster analysis, measures of relationship

Module-IV: Research report preparation and presentation: Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references

Module-V: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.International Scenario: International cooperation on Intellectual Property. Procedure for grantsof patents, Patenting under PCT

References:

- Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon
- Research Methodology – Methods and Techniques, C K Kothari, New Age International
- Design and Analysis of Experiments, D C Montgomery, Wiley
- Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley
- Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education

Subject: **Advanced Engineering Design (MEPBTT1)**

		Credits			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will he able to**

1 Understand the design process and design models

2 Analyze different theories of failures

3 Evaluate economic factors involved in design process

4 Apply strategies for product design of various applications

Syllabus Contents:

Module-I: Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability

Module-II: Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design. Importance of Fits and Tolerance influencing design:

Module-III: Team work and Ethics in engineering design: Team formation, functioning, discharge, team dynamics, Ethical issues considered during engineering design process

Module-IV: Product Design: Product strategies, Product value, Product planning, product specifications, concept generation, concept selection, concept testing.

Module-V: Design for manufacturing: Forging design, Casting design, Design process for non metallic parts, Plastics, Rubber, Ceramic, Wood, Glass parts. Material selection in machine design

References:

- Machine Design An Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey,USA
- Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGraw-Hill International Book Company, New Delhi
- Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition,McGraw- Hill International edition
- Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
- Engineering Design / George E Dieter / McGraw Hill /2008

Subject:	**Finite Elements in Design (MEPBTT2)**	**Credits**			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will he able to**

1 Make use of the concept of finite element method for solving machine design problems

2 Solve problems in 1-D structural systems involving bars, trusses, beams and frames

3 Develop 2-D and 3-D FE formulations involving triangular, quadrilateral elements and higher order elements

4 Apply the knowledge of FEM for stress analysis, model analysis, heat transfer analysis and flow analysis

5 Develop algorithms and FE code for solving design problems and adapt commercial packages for complex problems

Syllabus Contents:

Module-I: Introdnction: Historical Perspective of FEM and applicability to mechanical engineering design problems.

Mathematical Models and Approximations: Review of elasticity. Mathematical models for structural problems: Equilibrium of continuum-Differential formulation, Energy Approach- Integral formulation: Principle of Virtual work - Variational formulation. Overview of approximate methods for the solution of the mathematical models, Residual methods and weighted residual methods, Ritz, Rayleigh-Ritz and Gelarkin's methods. Philosophy of solving continuum problems using Finite Element Method.

Finite Element Formulation: Generalized FE formulation based on weighted residual method and through minimization of potential, displacement based formulation, Concept of discretization, Interpolation, Formulation of Finite element characteristic matrices and vectors, Compatibility conditions, Assembly and boundary considerations.

Module-II: Finite Element Analysis for One Dimensional Structural problems: Structural problems with one dimensional geometry. Bar element: formulation of stiffness matrix, consistent and lumped load vectors. Boundary conditions and their incorporation: Elimination method, Penalty Method, Introduction to higher order elements and their advantages and disadvantages. Formulation for Truss elements, Case studies involving hand calculations with an emphasis on Assembly, boundary conditions, contact conditions and multipoint constraints.

Beams and Frames: Review of bending of beams, higher order continuity (C0 and C1 Continuity), interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations. Algorithmic approach for developing computer eodes involving 1-D elements.

Module-III: Two dimensional Problems: Interpolation in two dimensions, natural coordinates, Isoparametric representation, Concept of Jacobian. Finite element formulation for plane stress plane strain and axi-symmetric problems; Triangular and Quadrilateral elements, higher order elements, sub-parametric, Isoparametric and superparametric elements. Formulation of plate bending elements using linear and higher order bending theories, Shell elements, General considerations in finite element analysis of design problems, Choosing an appropriate element and the solution strategies. Introduction to pre and post processing of the results and analysis.

Module-IV: FEM in Heat Transfer and Fluid Mechanics problems: Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems. Formulation for 2-D and 3-D heat conduction problems with convective boundaries. Introduction to thermo-elastic contact problems. Finite element applications in potential flows; Formulation based on Potential function and stream function. Case studies.

Module-V: Dynamic Analysis: FE formulation in dynamic problems in structures using Lagrangian Method, Consistent and lumped mass models, Formulation of dynamic equations of motion, Modelling of structural damping and formulation of damping

matrices, Model analysis, Mode superposition methods and reduction techniques.

Three Dimensional Problems: Finite element formulation for 3-D problems, mesh preparation, tetrahedral and hexahedral elements, case studies.Algorithmic Approach for problem solving: Algorithmic approach for Finite element formulation of element characteristics, Assembly and incorporation of boundary conditions. Guidelines for code development. Introduction to commercial Finite Element software packages like ANSYS.

References:

- Singiresu S.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012
- Seshu P, Textbook of Finite Element Analysis, PHI. 2004
- Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2017
- Zeincowicz, The Finite Element Method 4 Vol set, 4th Edition, Elsevier 2007

Subject:	**Noise, Vibration & Harsbness (MEPBTP)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will he ahle to**

1 Identify sources of noise and vibration

2 Measure sound intensity and human sensitivity

3 Model statistical energy analysis and simulators

4 Evaluate active control techniques

5 Identify and evaluate the signal processing techniques

Syllabus Contents:

Module-I: NVH in the Automotive Industry : Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

Module-II: Sound and Vibration Theory : Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials, Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

Module-III: Test Facilities and Instrumentation : Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis.

Module-IV: Signal Processing: Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

Module-V: NVH Control Strategies & Comfort: Source ranking. Noise path analysis. Modal analysis. Design of Experiments. Optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

References:

- Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,2001
- Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 2002
- Baxa, Noise Control of Internal Combustion Engine, John Wiley, 2000
- Ewins D. J., Model Testing : Theory and Practice, John Wiley,1995
- Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993
- McConnell K, "Vibration Testing Theory and Practice", John Wiley, 1995

Subject: **Computationai Fluid Dynamics (MEPBTP)**

		Credits			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will he able to**

1 Develop the governing equations and understand the behavior of the equations

2 Understand the stepwise procedure to completely solve a fluid dynamics problem using computational methods

3 Analyse the consistency, stability and convergence of discretization schemes for parabolic, elliptic and hyperbolic partial differential equations

4 Analyse variations of SIMPLE schemes for incompressible flows and variations of Flux Splitting algorithms for compressible flows

5 Evaluate methods of grid generation techniques and application of finite difference and finite volume methods to thermal problems

Syllabus Contents:

Module-I: Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods; Governing equations of fluid dynamics: Models of the flow, the substantial derivative, Physical meaning of the divergence of velocity, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, Time marching and space marching.

Module-II: Mathematical behavior of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations. Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points.

Module-III: Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization. Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.

Module-IV: Elliptic equations: Finite difference formulation, solution algorithms: Jacobi- iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods. Hyperbolic equations: Explicit and implicit finite difference formulations, Scalar representation of Navier-Stokes equations: Equations of fluid motion, numerical algorithms: ftcs explicit, ftbcs explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, btcs and btbcs implicit algorithms, applications.

Module-V: Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids. GRID GENERATION: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation. Finite volume metbod for unstructured grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements.

References:

- Anderson, J.D.(Jr), Computational Fluid Dynamics, McGraw-Hill Book Company, 1995
- Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000
- Chung, T.J., Computational Fluid Dynamics, Cambridge University Press, 2003

Subject:	**Optimization Methods for Engineering Design (MEPBTP)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will he able to**

1 Formulate a design task as an optimization problem

2 Identify constrained and unconstrained optimization problems and solve using corresponding methods

3 Solve discontinuous optimization problems using special methods

4 Solve nonlinear optimization problems with evolutionary methods

Syllabus Contents:

Module-I: Introduction to Optimization in Design: Problem formulation, Optimization problems in Mechanical Engineering, Classification of methods for optimization; Single-variable Optimization: Optimal criteria, Derivative-free methods (bracketing, region elimination), Derivative based methods, root-finding methods.

Module-II: Multiple-variable Optimization: Optimal criteria, Direct search methods (Box's, Simplex, Hooke-Jeeves, Conjugate methods), Gradient-based methods (Steepest Descent, Newton's, Marquardt's, DFP method). Formulation and Case studies. Constrained Optimization: KKT conditions, Penalty method, Sensitivity analysis, Direct search methods for constrained optimization, quadratic programming, GRG method, Formulation and Case studies.

Module-III: Specialized algorithms: Integer programming (Penalty function and branch-and-bound method), Geometric programming. Evolutionary Optimization algorithm: Genetic algorithms, simulated annealing, Anti-colony optimization, Particle swarm optimization.

Module-IV: Multi-objective Optimization: Terminology and concepts, the concepts of Pareto optimality and Pareto optimal set, formulation of multi-objective optimization problem, NSGA.

Module-V: Case studies and Computer Implementation: Representative case studies for important methods and development of computer code for the same to solve problems.

References:

- Jasbir Arora, Introduction to Optimum Design, Academic Press, 2004
- KalyanmoyDeb, Optimization For Engineering Design: Algorithms And Examples, PHI, 2004
- Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley, 2001

Subject: **Design Lab (MEPBPT1)**

		Credits			
Type:	ProgrammeCore	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will he able to**

1 Understand advanced features of MATLAB

2 Analyze single degree of freedom free and forced vibrations

3 Evaluate free and forced single and multi-degree of freedom vibration

4 Design suitable MATLAB code for engineering problems on vibrations

Syllabus Contents:

- To know the history and features of MATLAB & the local environment of MATLAB
- Free Vibration of Single Degree of Freedom Systems
- Forced Vibration of Single Degree of Freedom Systems
- Response Under a Periodic Force of Irregular Form
- Response Under a General Periodic Force
- Two Degree of Freedom Systems - Free Vibration analysis
- Multi-degree of freedom systems - Natural frequencies and mode shapes
- Free vibration of damped system
- Modal analysis for undamped systems
- Harmonic excitations

References:

- Lab Instruction Manual

Subject: **Modeling and Analysis Lab (MEPBPT2)**

		Credits			
Type:	ProgrammeCore	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will he able to**

1 Develop programs for modeling the synthetic curves and surfaces

2 Develop finite element code to solve problems involving Trusses, Beams and Frames

3 Solve structural problems using finite element software

4 Execute mini project involving both modeling and analysis

Syllabus Contents:

- Develop Programs for Transformations and Synthetic curves in CAD
- Model solids with features like Hole, Round, Chamfer and Rib
- Model solids with features like Pattern, Copy, Rotate, Move and Mirror
- Advanced modeling tools (Sweep, Blend, Variable section Sweep etc)
- Introduction to developing program for finite element analysis in MATLAB
- Solution of Trusses problems using the developed code
- Solution of Beams and Frames using the developed code
- Solution of problems involving triangular element using the developed code
- Introduction to FEA software, ANSYS
- Solution of problems of Trusses using ANSYS
- Solution of problems of Beams and Frames using ANSYS
- Solution of problems involving triangular element etc. using ANSYS
- Solution of 3D analysis problems using ANSYS

References:

- Lab Instruction Manual

Subject:	**Composite Materials (MEPBTO5)**	**Credits**			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will he able to**

1 Explain and also implement the composite materials for the required performance based on the characteristics.

2 Adopt the composite materials as reinforcements.

3 Implement the methods of manufacturing of metal matrix composites

4 Adopt the methods of manufacturing of polymer matrix composites

5 Evaluate the strength of laminates.

Syllabus Contents:

- INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.
- REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.
- Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.
- Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.
- Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations

References:

- Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
- Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.
- Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
- Hand Book of Composite Materials-ed-Lubin.
- Composite Materials – K.K.Chawla.
- Composite Materials Science and Applications – Deborah D.L. Chung.
- Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Subject: **Internet of Things (IoT) (ECPBTO7)**

		Credits			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will he able to**

1 Understand the concepts of Internet of Things.

2 Analyze basic protocols in wireless sensor network.

3 Design IoT applications in different domain and be able to analyze their performance

4 Elaborate the need for Data Analytics and Security in IoT.

5 Understand the concepts of Internet of Things.

Syllabus Contents:

Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting, IPV4 addressing and challenges), IPV6 addressing. IoT architecture reference layer. Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open source hardware, Examples of IoT infrastructure.

IoT and M2M

Software defined networks, network function virtualization, difference between SDN and NFV for IoT, Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER.

IOT protocols and Communication Technologies

MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP, COAP,XMPP and gateway protocols, IoT Communication Pattern, IoT Protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA, Lifi, Widi).

Data and Analytics for IoT

An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of IOT Security, Common Challenges in IOT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment.

IoT Physical Devices and Endpoints: Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C). Programming – Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins.

IoT Physical Servers and Cloud Offerings: Introduction to Cloud Storage models and communication APIs WebServer: Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API.

IoT application and its Variants: Case studies: IoT for smart cities, smart grid, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0,IoT standards.

References:

- "Internet of Things - A Hands-on Approach", ArshdeepBahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
- "Internet of Things",Srinivasa K G, CENGAGE Leaning India, 2017.
- " IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Ierome Henry1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
- "Getting Started with Raspberry Pi", Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.
- "From Machine to Machine to Internet of Things", Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, Elsevier Publications, 2014.

Department of Mechanical Engineering, School of Engineering & Technology, GGV, Bilaspur (C.G.)

ETPHDT00-RESEARCH METHODOLOGY IN ENGINEERING

Introduction and Design of research: Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

Data and Methods of Data Collection: Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability.

Data Analysis and Interpretation: Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, Testing of hypothesis, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution analysis of variance: one way, two-way, chi square test, z test and its application, student's 'T' distribution, Univariate and Bivariate analysis, regression analysis.

Report writing and presentation: Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references.

Research ethics, IPR and scholarly puhlishing: Ethics: Definition, moral philosophy, nature of moral judgments and reactions, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publication duplicates and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance, Publication's misconduct: definition, concept, problems that lead to unethical behavior and vice versa, Patents, Designs, Trade and Copyright. Process of Patenting and Development.

Reference Books:

1. Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon.
2. Research Methodology – Methods and Techniques, C K Kothari, New Age International.
3. Design and Analysis of Experiments, D C Montgomery, Wiley.
4. Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley.
5. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.
6. Research Methodology - Methods & Techniques, CR Kothri CR (1990), VishvaPrakashan, NewDelhi.
7. Research Methodology & Statistical Techniques, S Gupta (1999) Deep & Deep Publications, NewDelhi.
8. Research Methodology for Biological Sciences, N Gurumani (2007), MJP Publishers, Chennai.

9. Research Design:Qualitative, Quantitative &Mixed Method Approaches, JohnW. Creswell (2009), Sage Publication, USA

MEPHDT0I-MECHATRONIC SYSTEM DESIGN

Mechatronics System design:

Introduction to Mechatronics-Integrated design issues- Key elements and design processes-Physical system modelling - Electrical systems-Micro processor based controller and micro electronics- Mechanical translation and rotational systems-Electromechanical coupling-Fluid system

Actuating devices:

Direct current motor, Permanent magnet stepper motor, Mechanical actuation, Hydraulic and pneumatic power actuation devices, Linearand latching linear actuators, Rotatory actuators, Piezoelectric actuators, Actuator parameters and characteristics.

Sensors and Transducers:

An introduction to sensors and transducers, sensors for motion and position, Force torque and tactile sensors, Flow sensors, Temperature sensing devices, Ultrasonic sensors, Range sensors, Active vibration control using magneto structive transducers, Lasers and Opto mechatronics
based devices.

Software and Hardware components in Mechatronics systems:

Signals , system and controls, system representation, Signal conditioning and devices, PLC, system representation, linearization of nonlinear systems, Time delays and measurement of system performance, Elements of Data acquisition and control systems, real time interfacing.

MEMS and Microsystems:

Microsystems and miniaturization- lithography technique- Microactuators- actuation using shape memory alloys, piezo electric crystals and electrostatic forces- micro valves and pumps- micro sensors-Overview on applications of Robotics in automobiles and other industries.

Text books:

[1] W. Bolton, Mechatronics, Pearson publications (ISBN 978-81-3176253-3)
[2] DevdasShett, Richard A. Kolk, Mechatronics System Design,Brooks/Cole, Thomson learning(ISBN 0-534-95285-2).

Reference Books:

[1] John Watton, Fundamentals of Fluid power and control, Cambridgeuniversity press (ISBN 9780521762502)
[2] AndrejzM.Pawlak, Sensor and Actuators in Mechatronics Design,Taylor and Francis (ISBN-13:978-0-8493-9013-5)

[3] Tai-Ran Hsu, MEMS and Microsystems design and manufacture,Tata McGraw-Hill(ISBN0-07-048709-X)
[4] Stephen A.Campbell, The Science and Engineering ofmicroelectronic fabrication, Oxford university press(ISBN 0-19-568144-4)

MEPHDT02- RELIABILITY AND MAINTENANCE ENGINEERING

Fundamentals of reliability: Scope of reliability engineering, concept of bath tub curve, types of failure data, reliability estimations, constant failure rate models, time dependent failure rate models, concept of failure on demand, reliability estimation of series/parallel/mixed/complex system configuration, concepts of availability and maintainability.

Design for Reliability: Capturing user's reliability requirements, reliability and/or redundancy allocation/optimization, design methods, FMEA/FMECA, reliability testing (burn-in testing,
reliability assurance testing, reliability growth testing, accelerated life testing), fault tree analysis.

Availahility Assessment: Markov modelling approach for availability estimation.

Maintenance Management: Corrective, preventive and predictive maintenance. Age and time based preventive maintenance, opportunistic maintenance, concepts of imperfect maintenance, concept of TPM and RCM, maintenance optimization.

Remaining useful life prediction of equipments subject to condition monitoring: ANN models, ARMA models, Markovmodels, proportional hazard models.

Suggested Books

[I] CharlesEbeling, An Introduction To Reliability andMaintainability Engineering, Waveland PrInc; 2 Har/Cdredition, 2009.
[2] Igor Bazovsky, Reliability Theory and Practice, DoverPublications (October, 2004).
[3] Patrick O'Connor, Practical Reliability Engineering, JohnWiley & Sons Inc.2002.
[4] Gregg K. Hobbs, Accelerated Reliability Engineering: HALTand HASS, Wiley, 2000.
[5] G. Vachtsevanos, F.L. Lewis, M. Roemer, A. Hess and B. Wu,Intelligent Fault Diagnosis and Prognosis for EngineeringSystems. John Wiley & Sons, 2006.

MEPHDT03-COMPOSITE MATERIALS

Introduction: classifications, terminologies, manufacturing processes.

Macro-mechanical analysis of lamina: Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials–2D Unidirectional and angle ply lamina –

Strength theories of lamina.

Micro-mechanical analysis of lamina: Volume and mass fraction, density and void content – Evaluation of Elastic module, Ultimate strength of unidirectional lamina.

Macro-mechanical analysis of laminates: Laminate code, Stress strain relations – In-plane and Flexural modulus, Hydro thermal effects.

Failure Analysis and Design: Special cases of laminates, symmetric, cross ply, angle ply and anti symmetric laminates, failure criteria and failure modes

Suggested Books

[1] Jones, R M, Mechanics of Composite Materials, Scripta BookCo.

[2] Agarwal, B D and Broutman, J. D, Analysis and Performance of Fiber Composites, New York, John Willey and Sons, 1990

[3] Mallik, P. K, Fiber reinforced composites : materials, manufacturing and design, New York- Marcel and Dekker,1993 (2ndedition)

[4] Arthur, K Kaw, Mechanics of Composite Materials, CRC Press, 1997.

[5] Reddy J N, Mechanics of Laminated Composite Plates, CRC Press

[6] Mallik, P. K, Composite Engineering Hand Book, New York, Marcel and Dekker, 1997 (2nd edition)

MEPHDT04-MATERIAL CHARACTERIZATION TECHNIQUES

Introduction: Requirement of different techniques of material characterization for different situations. Mechanical and physical characterization.

Optical Metallographic Techniques: Observation of microstructure. Preparation of samples (polishing, etching etc.)

Mechanical Characterization Processes: Measurement of hardness. Measurement of fracture toughness through nano indentation. Adhesion test. Surface profilometry. Tribological studies of materials.

Physical Characterization Processes: Introduction to different methods and their applications. Diffraction methods for phase, residual stresses, texture analysis etc.; Electro-optical and related techniques like SEM, TEM, EDS, WDS/EPMA etc.; Surface analysis and related techniques like XPS, AFM etc.; Spectroscopic techniques.

Suggested Books

[1] C. R. Brundle, Charles A. Evans, Shaun Wilson, Encyclopedia of materials characterization: surfaces, interfaces, thin films, Material Characterization Series, Surfaces, Interfaces, Thin Films, Butterworth-Heinemann.

[2] B.D. Cullity, Elements of X-Ray Diffraction (3rd Edition),Prentice Hall

[3] Said Jahanmir, Friction and Wear of Ceramics, CRC Press

[4] P J Goodhew, J Humphreys, R Beanland, Electron Microscopy and Analysis, 3rd edition, Taylor and Francis,London

MEPHDT05-ADVANCED MACHINING PROCESSES

Introduction: Types of advanced machining processes (AMPs); evolution, and need.
Mechanical Type AMPs: process principle and elements; Mechanism of material removal, parametric analysis; Shape and material applications; Operational characteristics; Limitations of USM, AJM, WJM, AWJM processes.

Advanced Fine Finishing Process: Process principle, processequipment, parametric analysis, Applications of Abrasive FlowMachining (AFM); Magnetic Abrasive Finishing; MagnetoRheological Abrasive Finishing (MRF) processes.

Chemical Type AMPs: Process principle and details of Chemical Machining (CHM); Photo-Chemical Machining (PCM), and Bio-Chemical Machining processes (BCM).

Electro Chemical Type AMPs: ECM-Process principle, mechanism of material removal; Kinematics and dynamics and dynamics of ECM; Tooling design; Choice and analysis of process parameters; Surface finish and accuracy.

Thermal Type AMPs: Working principle; Power circuits; Mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy, Shape and materials applications, limitations of EDM, LBM, EBM, IBM,PAM processes.

Derived and Hybrid AMPs: Introduction of processes like rotary ultra sonic machining (RUM), electro stream drilling(ESD), shaped tube electro machining (STEM), wire electro discharge machining (WEDM), electro chemical grinding (ECG),electro chemical honing (ECH), electro chemical debarring(ECD), and electro-chemical spark machining (ECSM).

Suggested Books

[1] G.F. Benedict, Non traditional Manufacturing Processes, Marcel Dekker, Inc. New York, 1987.

[2] V.K. Jain Advanced Machining Processes, Allied Publishers, New Delhi, 2002.

[3] A. Ghosh, and A.K. Mallik, Manufacturing Science, Affiliated East-West Press Ltd, New Delhi, 1985.

[4] P.C. Pandey, and H.S. Shan, Modern Machining Processes, Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 1980.

[5] J.A. Mc Geough, Advance Methods of Machining, Chapman and Hall, London, 1988.

MEPHDT06-MICRO AND PRECISION MANUFACTURING

Micro-manufacturing: Introduction to different mili-machining, micromachining, Nano-machining processes, Micro and nano finishing processes, Micro-forming, Micro-joining techniques, nanotechnology processes, the related process mechanism, process parameters of these processes and their applications to production of miniaturized components.

Micro-machines: - Introduction, Mesoscopic domain, Biological systems, cells as machines, Role of proteins, Physics of micromechanism, Future prospects.

Precision manufacturing: Introduction, concept of accuracy, tolerance and fits, influence of different factors on the maintainability of accuracy of the machine tools and the product, compensation of thermal errors and location errors, effects of vibration and tool wear, dimensioning and dimensional chains.

Metrology and Characterization Techniques for Micro and Precision Manufactured Products: Profilometric, Microscopic, diffractometric, and electron beam based techniques.

Suggested Books

[1] l. Fujimasa, "Micromachines: A New Era in Mechanical Engineering", Oxford Science Publications.

[2] J. Paulo Davim, Mark J. Jackson, “Nano and Micromachining”, Wiley-ISTE

[3] N.P. Mahalik, “Micromanufacturing and Nanotechnology",Springer

[4] P.C. Pandey and H.S. Shan, "Modern MachiningProcesses", Tata McGraw Hill Publication.

[5] V. K. Jain (Ed.), lntroduction to Micromachining, Narosa Publishing House, New Delhi, 2010.

[6] Yi Qin, Micromanufacturing Engineering and Technology, Elsevier, 2010 (ISBN 13: 978-0-8155-1545-6)

[7] R.L. Murty, "Precision Engineering in Manufacturing", New Age International Publishers.

[8] C. R. Brundle, Charles A. Evans, Shaun Wilson,Encyclopedia of materials characterization: surfaces, interfaces, thin films, Material Characterization Series, Surfaces, Interfaces, Thin Films, Butterworth-Heinemann.

MEPHDT07-INDUSTRIAL AUTOMATION

Basic Concepts: Introduction of Mechanization and Automation, Classification and Strategies of Automation, Reasons for and Arguments against Automation. Mechanical, Electrical, Hydraulic, and Pneumatic Devices and Controls

High Volume Manufacturing or Hard Automation: Automated Flow Lines, Types of Automatic Transfer Mechanisms, Design and Fabrication Considerations, Analysis of Automated Flow Lines.

Assembly Automation: Assembly Systems and their Types, Manual Assembly Lines and Line Balancing, Automated Assembly Lines and their Types, Automatic Assembly Transfer Systems, Automatic Feeding and Orienting Devices:- Vibratory and Mechanical Feeders and their types, Orientation of Parts, Performance and Economics of Assembly Systems, Feasibility Study for Assembly Automation.

Design for Assembly: Design for Manual Assembly, Design for High-Speed Automatic Assembly, Design for Robotic Assembly

Programmahle Automation: Brief Introduction of Numerical Control (NC), Computer Numerical Control (CNC), Machining Centers, Programmable Robots, Direct Numerical Control(DNC), and Adaptive Control.

Flexible Automation: Introduction of Group Technology (GT),Steps in Implementing GT, Part Families and Machine Cell Formation, Introduction of Flexible Manufacturing Systems (FMS).

Suggested Books

[1] M. P. Groover, "Automation, Production systems and Computer Integrated Manufacturing", Prentice-Hall Inc. Englewood Cliffs, 1987. [Indian Edition from Prentice Hall of India, New Delhi].

[2] G. Boothroyd "Assembly Automation and Product Design", Marcel Dekker, New York, 1992.

[3] G. Boothroyd, P. Dewhurst, and W. Knight "Product Design for Manufacture and Assembly (2nd Edition)", Marcel Dekker, New York, 2002.

[4] G. Boothroyd, C. Poli, and L. E. Murch, "Automatic Assembly", Marcel Dekker Inc. New York, 1982.

[5] G. Boothroyd, and A. H. Redford, "Mechanized Assembly: Fundamentals of Parts Feeding, Orientation and Mechanized Assembly", McGraw Hill Publishing Co. Ltd., London, 1968

MEPHDT08 ENGINEERING DESIGN METHODOLOGY

Fundamentals: principles of design, systematic approach, need analysis and design of specification; Conceptual design: developing function structure, developing concepts by systematic search with physical principles, classifying schemes; Concept selection: matrix methods, necessity methods, probability methods, fuzzy set based methods, case study on consumer product; Embodiment design: basic rules, system modelling, preliminary design calculations and material selection, design considerations like force alignment, vibration etc., failure modes and effects analysis, design for manufacturability and assembly, case studies on design of machines; Optimal and robust design: design problem formulation for analytical and numerical solution, design of experiments, Taguchi's method; Reverse engineering; Physical prototyping; Lab: conceptual design, reverse engineering, design of simple sensors and actuators, hydraulic and pneumatic systems, motors and controller, product teardown and redesign, embodiment design, CAE analysis, prototyping, design project.

Textbooks:

[1] Yousef Haik, Engineering Design Process, Vikas Publishing house, New Delhi, 2003.

[2] G. Pahl, and W. Beitz, Engineering Design – A Systematic Approach, Springer – Verlag, 1996

Reference books:

[3] K. Otto and K. wood, Product Design – techniques in reverse engineering and new product development, Pearson Education, New Delhi, 2004.

[4] A. Ertas and J. C. Jones, The Engineering Design Process, 2nd ed., John Wiley and Sons, 1996.

[5] A. Kusiak, Engineering Design – Products, Processes and Systems, Academic Press, 1999.

[6] C. L. Dym and P. Little, Engineering Design – A Project based Introduction, John Wiley, 2000.

[7] G. E. Dieter, Engineering Design – A Materials and Processing Approach, 3rd ed., McGraw-Hill International, 2000.

[8] E. Kroll, S. S. Condoor and D. G. Jonsson, Innovative Conceptual Design – Theory and Application of Parameter Analysis, Cambridge Univ. Press, 2001

MEPHDT09 FINITE ELEMENT METHODS IN ENGINEERING

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method; Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post processing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame. Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages.

Text books:

[1] J N Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 1993.

[2] R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3d ed., John Wiley, New York, 1989.

[3] K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.

[4] T J T Hughes, The Finite Element Method, Prentice-Hall, Englewood Cliffs, NJ, 1986

[5] O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed. McGraw-Hill, 1989.

MEPHDT10-FRACTURE, FATIGUE AND FAILURE ANALYSIS

Griffith's theory of brittle failures; Irwin's stress intensity factors; Linear elastic fracture mechanics: The stress analysis of crack tips, Macroscopic theories in crack extension, Instability and R-curves, Crack tip plasticity, K as a failure criterion, Mixed mode of fracture, Analytical and Experimental methods of determining K; Elastic plastic fracture mechanics: Crack tip opening displacement, J Integrals, Crack growth resistance curves, Crack tip constraint under large scale yielding, creep crack growth; Microscopic theories of fracture: Ductile and cleavage fracture, ductile-brittle transition, inter-granular fracture; Fatigue crack propagation: Fatigue crack growth theories, crack closure, Microscopic theories of fatigue crack growth; Application of theories of fracture mechanics in design and materials development

Text books:

[1] T. L. Anderson, Fracture Mechanics Fundamentals and Applications, CRC Press, 1994

[2] D. Brock, Elementary Engineering Fracture Mechanics, Maritinus Nijhoff Publishers, 1982.

[3] S. T. Rolfe and J. M. Barson, Fracture and Fatigue Control in Structures, PHI, 1977

MEPHDT11- PHYSICS OF MANUFACTURING PROCESSES

Introduction of manufacturing processes from the point of view of underlying physics. Stresses and Strain: stress and strain behaviour of materials, plastic and tangent modulus, work hardening, plastic instability in tensile test, empirical stress-strain equations, effect of pressure, strain-rate and temperature, analysis of stress tensor, eigen values, decomposition into deviatoric and hydrostatic components, octahedral stresses, analysis of strain and strain-rates, stress equilibrium and virtual work, objective stress rates. Plasticity: the criteria of yielding, isotropic and anisotropic hardening, rules of plastic flow, Levy-Mises and Prandtle-Reuss equations, anisotropic flow rule, Hill's 1948 and 1979 yield criteria for anisotropic yielding. Upper bound theorem and its application in processes like rolling, wire drawing, extrusion, forging and machining. Lower bound theorem with a few applications. Slab method and its application in process like asymmetric rolling, forging, wire drawing and extrusion. Elasto plastic sheet bending. Analysis of auto frettaging. Theory of slipline field and its application in metal forming and machining. Heat transfer analysis in manufacturing. Workability and dynamic materials model.

Text books:

[1] Chakrabarty, J., Theory of plasticity, McGraw Hill Book Company, Singapore, 1998.

[2] Johnson, W. and Mellor P.B., Engineering plasticity, Von NostrandReinhold Company, London, 1972.

[3] Bhattacharyya, A., Metal cutting: theory and practice, New Central Book, Kolkata, 1984.

[4] Incropera, F.P. and DeWiit, D.P., Fundamentals of heat and mass transfer, John Wiley & Sons, Singapore.

[5] Prasad, Y.V.R.K., Sasidhara, S., Hot working guide: a compendium of processing maps, ASM International, Materials Park, OH, 1997

MEPHDT12-ENERGY CONSERVATION AND WASTE HEAT RECOVERY

Energy resources and use. Potential for energy conservation. Optimal utilization of fossil fuels. Total energy approach. Coupled cycles and combined plants. Cogeneration systems. Exergy analysis. Utilization of industrial waste heat. Properties of exhaust gas. Gas-to-gas, gas-to-liquid heat recovery systems. Recuperators and regenerators. Shell and tube heat exchangers. Spiral tube and plate heat exchangers. Waste heat boilers: various types and design aspects. Heat pipes: theory and applications in waste heat recovery. Prime movers: sources and uses of waste heat. Fluidized bed heat recovery systems. Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems. Thermoelectric system to recover waste heat. Heat pump for energy recovery. Heat recovery from incineration plants. Utilization of low grade reject heat from power plants. Need for energy storage: Thermal, electrical, magnetic and chemical storage systems. Thermo-economic optimization.

References Books:

[1] J. H. Harlock, Combined Heat and Power, Pergaman Press, 1987

[2] F. Kreith and R. E. West, Energy Efficiency, CRC handbook, CRC Press,1999

[3] Kays and London, Compact Heat Exchangers, 3rd edition, McGraw-Hill, New York.

MEPHDT13- SUPPLY CHAIN AND LOGISTIC PERFORMANCE MANAGEMENT

UNIT I:

Supply Chain Management and sustainability:

Core of supply chain and management and its components, how supply chain works, Importance of supply chain, Supply chain networks, big data in the supply chain, supply chain analytics and its differentiator. SC sustainability concept, pillars and challenges in current modern organizations.

UNIT II:

Supply chain management strategies:

Introduction of SC strategies, the concept, nature, scope, importance of lean SC strategy-theoretical Models, eights kinds of waste. Sustainable supply chain strategies, Green SC management objective, model and current policy. Agile and Le-Agile strategies to sustainable SC, Resilient strategy contribution to sustainable SC.

UNIT III:

Performance Measurement and its models:

SC performance measurement, measures, metrics, SC strategic goals, Supply chain performance and SCOR model, Maturity models, Reference models, and Benchmarking model, Application of model towards supply chain. Types of information, Estimation of various types of costs. Application and appraisal of metrics and KPIs.

UNIT IV:

Planning Demand and Supply in SC:
Demand Forecasting in a Supply Chain: The Role of Forecasting in a Supply Chain ,Characteristics of Forecasts, Components of a Forecast and Forecasting Methods ,Basic Approach to Demand Forecast1ng, Time-Series Forecasting Methods ,Measures of Forecast Error, Risk Management in Forecasting , Forecasting in Practice.

UNIT V:

Logistic SC

Logistic Management-Forward and reverse supply chain measures and metrics, Role of transportation in supply chain, modes of transport, transportation in practice, Logistic Equipments, Sourcing Decisions in Supply Chain- role of sourcing, third and fourth party logistics providers, supplier scoring & assessment, Supplier selection -auctions, and negotiations, contracts, procurement process.

Reference books:

1.Supply Chain Management: Janat Shah, Pearson Publications.
2. Supply Chain Management: Sunil Chopra and Mein del, Fourth Edition, PHI.

3. Supply Chain Management: A.S.Altekar PHI Second Ed.
4. Logistics Management: James Stock and Douglas Lambert. McGraw Hill International Ed.
5. Supply Chain Management for Global Competitiveness:Ed.B.S.Sahay McMillan Publication
6. Emerging Trends in Supply Chain Management: Ed.B.S.Sahay McMillan Publication. 7. Logistics Management: Bowersox TMH.

MEPHDT14- PRODUCTION AND OPERATIONS MANAGEMENT

UNIT I: INTRODUCTION TO OPERATIONS MANAGEMENT

History and concept of production and operations management, strategic importance of Operations Management; decisions in operations: products and service, process and technology, Capacity and facilities, human resources, quality, and sourcing. Tools of decision-making decision in operations using excel

UNIT II: PRODUCTION PROCESS DESIGN & MANAGEMENT

Types of processes: Projects, batch production, Mass Production, continuous production; Process Planning: Make or buy Design, Process selection with break-even analysis, Process plans; Process analysis, Process Innovation, Technology Decisions, Job sequencing algorithms-Johnsons rule.

UNIT III: PRODUCT DESIGN

Product Design Process: Idea generation, feasibility study, Form Design, functional Design, final design and process plans; Technology in Design, Design Quality Review, Design for Environment, Metrics for design quality, Design for Manufacture & Assembly (DFMA), Quality Function Deployment.

UNIT IV: PRODUCTION FACILITIES DESIGN

Facility location, Basic Layouts-process, product, fixed position layouts; Designing process layout: block diagramming, relationship diagramming, computerized solutions; Designing a service Layouts, Shared spaces, Designing Product Layouts: Line balancing, computerized line balancing; Hybrid Layouts- Cellular, flexible manufacturing systems, Mixed model assembly lines

UNIT V: QUALITY MANAGEMENT

Evolution of Quality Management System, Quality Management: Statistical Process control, TQM, Cost of Quality, Effect of Quality Management on Productivity, Quality improvement: JIT, Kaizen approach; Work measurements-work study, time study; Forecasting, Inventory management, Human Resource management in operations.

Text books

1. Operations Management by Roberta S. Russell and Bernard W. Taylor (III); Pearson Education, 2003 edition.
2. R. Panneerselvam, Production & Operations Management, PHI
3. S.N. Chary, Production & Operations Management, TMH
4. Shailendra Kale, Production and Operations Management, McGraw Higher Ed.
5. Operations Management, Arun Kumar and N. Meenakshi, Cengage Learning
6. K.C. Jain, Production and Operations Management, Wiley India.

MEPHDT15- DESIGN OF SOLAR THERMAL SYSTEMS AND APPLICATIONS

Solar Radiation Fundamental: Basics of Solar Radiation, instruments for measuring solar radiation, solar radiation geometry, empirical equations, solar radiation on tilted surfaces.

Low and Medium temperature solar thermal technology: Flat plate, Evacuated tube collectors and PVT collectors- Basic elements, performance analysis, transmissivity - absorptivity, heat transfer coefficients and correlations, collector efficiency and heat removal factors, effects of various parameters, transient analysis. Energy balance of components, design process and parameters.

High-temperature solar thermal technology: Concentrating Solar Thermal (CST) Technologies, types - Parabolic Trough Collector, Linear Fresnel, Solar Tower, Parabolic Dish, Solar Furnace; general characteristics, geometry, heat transfer correlations, tracking requirements, performance analysis and design process, use of various HTF.

Application of Solar thermal energy: Solar Air heaters, Solar Drying, solar pond, solar refrigeration, Solar cooking, solar still, Solar Distillation-Desalination, Solar thermal power plants, Industrial process heat, etc.

Case studies on Recent Developments in the Solar thermal Collectors: Highlights of the latest heat transfer enhancement techniques such as use of novel selective coatings with nano particles, HTF with nano particles, use of fins and different surface geometry, Artificial surface roughness, Integration of novel Energy storage medium, thermal energy storage – sensible and latent heat etc.

REFERENCE BOOKS:

1. Foster .R, Ghassemi M., Cota A., "Solar Energy", CRC Press, 2010.
2. Duffie .J.A, Beckman W.A. "Solar Engineering of Thermal Processes", 3rd ed., Wiley, 2006.
3. De Vos .A, "Thermodynamics of Solar Energy Conversion", Wiley-VCH, 2008.
4. Garg .H.P, Prakash .J, "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
5. Kalogirou .S, "Solar Energy Engineering", Processes and Systems, Elsevier, 2009.
6. Tiwari G. N. (2002); Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa.
7. María Isabel Roldán Serrano, "Concentrating Solar Thermal Technologies: Analysis and Optimisation by CFD Modelling", Springer International, 2017.
8. Brian Norton, "Solar Energy Thermal Technology" Springer, 1992
9. G. Lorenzini, C. Biserni & G. Flacco "Solar Thermal and Biomass Energy" WIT Press 2010.
10. Zhifeng Wang, "Design of Solar Thermal Power Plants", Elsevier, 2019.
11. Manuel J. Blanco and Lourdes Ramirez Santigosa "Advances in Concentrating Solar Thermal Research and Technology" Woodhead Publishing, 2017

MEPHDT16- MODELING AND ANALYSIS OF SOLAR SYSTEMS

UNIT I - MATHEMATICAL MODELING

Principles of mathematical modelling; systems, models, simulations; definitions of mathematical models; classification of mathematical models.

UNIT II – PHENOMENOLOGICAL MODELS

Elementary statistics; Regression techniques – linear, multiple-linear, non-linear; Neural networks; Design of experiments.

UNIT III – MECHANISTIC MODELS

Ordinary differential equations and Partial differential equations; setting up of differential equations; Closed form solutions; Numerical solutions

UNIT IV –ENERGY MODELLING

Introduction; Energy and climate change; Atmospheric environment and renewable energy; Solar energy models – Solar energy deterministic models

UNIT V – SOLAR ENERGY MODELS

Linear solar energy models; Non linear solar energy models; Solar radiation devices and collectors; Case studies of solar energy modelling and analysis

REFERENCES BOOKS

1. Velten, K, "Mathematical Modelling and Simulation – Introduction for Scientists and Engineers", Wiley-VCH., 2009.
2. Sen .Z, "Solar Energy: Fundamentals and Modeling Techniques", Turkey, 2008.
3. Dym .C.L, "Principles of Mathematical Modeling", Elsevier, 2004.
4. Duffie .J.A, Beckman W.A. "Solar Engineering of Thermal Process", Wiley, 3rd ed. 2006.
5. Kalogirou .S.A, "Solar Energy Engineering: Processes and Systems", Academic Press, 2009.