NATIONAL INSTITUTE OF TECHNOLOGY: TIRUCHIRAPPALLI – 620 015

ACADEMIC OFFICE

B.Tech. Curriculum Structure – Students admitted in 2019 – 20

Semester I (July Session)

Sl. No.	Course Code	COURSE	Credits	Category
1	HSIR11	English for Communication (Theory & Lab)	4	GIR
2	MAIR11	Matrices and Calculus	3	GIR
3	CHIR11	Chemistry	3	GIR
4	CHIR12	Chemistry Lab	2	GIR
5	PRIR15	Introduction to Production Engineering	2	GIR
6	EEIR11	Basics of Electrical and Electronics Engineering	2	GIR
7	MEIR12	Engineering Graphics	3	GIR
		Total	**19**	

Semester II (January Session)

Sl. No.	Course Code	COURSE	Credits	Category
1	MAIR21	Complex Analysis and Differential Equations	3	GIR
2	PHIR11	Physics	3	GIR
3	PHIR12	Physics Lab	2	GIR
4	CSIR11	Introduction to Computer Programming	3	GIR
5	CEIR11	Basics of Civil Engineering	2	GIR
6	ENIR11	Energy and Environmental Engineering	2	GIR
7	PRIR11	Engineering Practice	2	GIR
8	PRPC10	Applied Mechanics	4	PC
9	**SWIR11**	NSS/NCC/NSO	0	GIR
		Total	**21**	

Semester III (July Session)

Sl. No.	Course Code	COURSE	Credits	Category
1	HSIRYY[$]	Industrial Economics and Foreign Trades	3	GIR
2	PRPC11	Casting and Welding Technology	4	PC
3	PRPC12	Metallurgy and Materials Engineering	3	PC
4	PRPC13	Fluids and Thermal Engineering	4	PC
5	PRPC14	Forming and Machining Technology	4	PC
6	PRLR10	Manufacturing Processes Lab.	2	ELR
7	PRLR11	Weldability and Formability Lab.	2	ELR
8	PRXXXX	Elective – I	3	PE/OE
		Total	**25**	

$ YY represents last two digits to be allotted by the Department.

Note: Department(s) to offer Minor (MI) Course and ONLINE Course (OC) to those willing students in addition to 23 credits.

Semester IV (January Session)

Sl. No.	Course Code	COURSE	Credits	Category
1	MAIRYY	Probability and Statistics	4	GIR
2	PRPC15	Kinematics and Dynamics of Machines	4	PC
3	PRPC16	Metrology, Quality and Safety	3	PC
4	PRPC17	Computer Numerical Control (CNC) Systems	3	PC
5	PRLR12	Metrology and Computer Numerical Control Machines Lab.	2	ELR
6	PRLR13	Machine Drawing (CAD) and Cost Estimation	2	ELR
7	PRXXXX	Elective – II	3	PE/OE
8	PRXXXX	Elective – III	3	PE/OE
		Total	**24**	

Note: Department(s) to offer MI/PE/OE/OC and Honours course as 2/3 credits to those willing students in addition to 24 credits.

Semester V (July Session)

Sl. No.		COURSE	Credits	Category
1	PRPC18	Industrial Automation and Mechatronics	3	PC
2	PRPC19	Design of Machine Elements	4	PC
3	PRPC20	Manufacturing System Simulation	3	PC
4	PRPC21	Manufacturing Tooling and Automated Inspection	4	PC
5	PRLR14	Manufacturing System Simulation Lab.	2	ELR
6	PRLR15	Mechatronics and Industrial Automation Lab.	2	ELR
7	HSIRYY	Professional Ethics	3	GIR
8	PRXXXX	Elective – IV	3	PE/OE
		Total	**24**	

Note: Department(s) to offer MI/PE/OE/OC and Honours course as 2/3 credits to those willing students in addition to 23 credits.

Semester VI (January Session)

Sl. No.		COURSE	Credits	Category
1	**XXIR17**	Industrial Lecture	1	GIR
2	PRPC22	Operations Research	4	PC
3	PRPC23	Analysis of Production Systems	3	PC
4	PRPC24	Computer Aided Design and Rapid Prototyping	3	PC
5	PRLR16	Advanced Manufacturing Lab.	2	ELR
6	PRLR17	Industrial Engineering Lab.	2	ELR
7	PRXXXX	Elective – V	3	PE/OE
8	PRXXXX	Elective - VI	3	PE/OE
9	PRXXXX	Elective - VII	3	PE/OE
		Total	**24**	

Note: Department(s) may offer Minor (MI) Course, ONLINE Course (OC) and Honours Course (HO) to those willing students in addition to 23 credits

Semester VII (July Session)

Sl. No.		COURSE	Credits	Category
1	XXIR16	Summer Internship	2	GIR
2	PRXXXX	Elective – VIII	3	PE/OE
3	XXXXXX	Elective – IX	3	PE/OE
4	XXXXXX	Elective – X	3	PE/OE
5	XXXXXX	Elective – XI	3	PE/OE
		TOTAL	**14**	

Note: Department(s) may offer Minor (MI) Course, ONLINE Course (OC) and Honours Course (HO) to those willing students in addition to 14 credits

Semester VIII (January Session)

Sl. No.		COURSE	Credits	Category
1	XXIR18	Comprehensive Viva Voce	1	GIR
2	XXIR19	Project Work$ / Equivalent no. of Electives	**6**	
3	XXXXXX	Elective – XII	3	PE/OE
4	XXXXXX	Elective – XIII	3	PE/OE
5	XXXXXX	Elective – XIV	3	PE/OE
		TOTAL	**10**	

Note: Department(s) may offer Minor (MI) Course, ONLINE Course (OC) and Honours Course (HO) to those willing students in addition to 10 credits

$Optional course

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credit	19	21	25	24	24	24	14	10	161

Note:

1. Minimum of 4 programme core courses shall be 4 credits each.
2. Out of 14 elective courses (PE/OE), the students should study **at least eight programme elective courses (PE).**
3. MI – Minor Degree: **15 credits over and above** the minimum credit as specified by the departments. The details of MINOR will be mentioned only in the transcript not in the Degree certificate.
4. HO – Honours Degree: **15 credits over and above** the minimum credit as specified by the departments. The project work is compulsory.

GENERAL INSTITUTE REQUIREMENTS (Course and Course details)

1. MATHEMATICS

Sl.No.	Course Code	Course Title	Credits
1.	**MAIR11**	**Matrices and Calculus**	**3**
2.	**MAIR21**	**Complex Analysis and Differential Equations**	**3**
3.	**MAIRYY**	**Probability and Statistics**	**4**
Total			**10**

2. PHYSICS

Sl.No.	Course Code	Course Title	Credits
1.	**PHIR11**	**Physics**	**3**
2.	**PHIR12**	**Physics Lab**	**2**
Total			**5**

3. CHEMISTRY

Sl.No.	Course Code	Course Title	Credits
1.	**CHIR11**	**Chemistry**	**3**
2.	**CHIR12**	**Chemistry Lab**	**2**
Total			**5**

4. HUMANITIES

Sl.No.	Course Code	Course Title	Credits
1.	HSIRYY	**Industrial Economics and Foreign Trade**	**3**
Total			**3**

5. COMMUNICATION

Sl.No.	Course Code	Course Title	Credits
1.	**HSIR11**	**English for Communication (Theory &lab)**	**4**
Total			**4**

6. ENERGY AND ENVIRONMENTAL ENGINEERING

Sl.No.	Course Code	Course Title	Credits
1.	**ENIR11**	**Energy and Environmental Engineering**	**2**
Total			**2**

7. PROFESSIONAL ETHICS

Sl.No.	Course Code	Course Title	Credits
1.	HSIRYY	**Professional Ethics**	**3**
Total			**3**

8. ENGINEERING GRAPHICS

Sl.No.	Course Code	Course Title	Credits
1.	**MEIR12**	**Engineering Graphics**	**3**
Total			**3**

9. ENGINEERING PRACTICE

Sl.No.	Course Code	Course Title	Credits
1.	**PRIR11**	**Engineering Practice**	**2**
Total			**2**

10. BASIC ENGINEERING

Sl. No.	Course Code	Course Title	Credits
1.	CEIR11 MEIR11	Basics of Civil Engineering (Except CE) Basics of Mechanical Engineering (For CE only)	2
2.	EEIR11	Basics of Electrical and Electronics Engineering	2
Total			**4**

11. INTRODUCTION TO COMPUTER PROGRAMMING

Sl.No.	Course Code	Course Title	Credits
1.	CSIR11	Introduction to Computer Programming (Theory and Lab)	3
Total			**3**

12. BRANCH SPECIFIC COURSE

Sl.No.	Course Code	Course Title	Credits
1.	XXIR15	Branch Specific Course – Introduction to Production Engineering	2
Total			**2**

13. SUMMER INTERNSHIP#

Sl.No.	Course Code	Course Title	Credits
1.	XXIR16	Internship / Industrial Training / Academic Attachment	2
Total			**2**

The student should undergo industrial training/internship for a minimum period of two months during the summer vacation of 3rd year. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training.

 # To be evaluated at the beginning of VII semester by assessing the report and seminar presentations.

14. INDUSTRIAL LECTURE

Sl.No.	Course Code	Course Title	Credits
1.	XXIR17	Industrial Lecture	1
Total			1

A course based on industrial lectures shall be offered for 1 credit. A minimum of five lectures of two hours duration by industry experts will be arranged by the Department. The evaluation methodology, will in general, be based on quizzes at the end of each lecture.

15. COMPREHENSIVE VIVA

Sl.No.	Course Code	Course Title	Credits
1.	XXIR18	Comprehensive viva	1
Total			1

16. PROJECT WORK (OPTIONAL COURSE)

Sl.No.	Course Code	Course Title	Credits
1.	XXIR19	Project Work (Optional)	6
Total			6

17. NSS /NCC/ NSO

Sl.No.	Course Code	Course Title	Credits
1.	SWIR11	NSS / NCC/ NSO	0
Total			0

Programme Core Courses

Sl. No.	Course Code	Course Title	Pre requisites	Credits
1.	PRPC10	Applied Mechanics	---	4
2.	PRPC11	Casting and Welding Technology	PRIR15	4
3.	PRPC12	Metallurgy and Materials Engineering	CHIR11	3
4.	PRPC13	Fluids and Thermal Engineering	---	4
5.	PRPC14	Forming and Machining Technology	PRIR15, PRPC12	4

6.	PRPC15	Kinematics and Dynamics of Machines	PRPC10	4
7.	PRPC16	Metrology, Quality and Safety	PHIR11	3
8.	PRPC17	Computer Numerical Control (CNC)	PRPC14	3
9.	PRPC18	Industrial Automation and Mechatronics	EEIR11	3
10.	PRPC19	Design of Machine Elements	PRPC10	4
11.	PRPC20	Manufacturing System Simulation	MAIRYY	3
12.	PRPC21	Manufacturing Tooling and Automated Inspection	PRPC19	4
13.	PRPC22	Operations Research	MAIRYY	4
14.	PRPC23	Analysis of Production Systems	---	3
15.	PRPC24	Computer Aided Design and Rapid Prototyping	CSIR11	3
		Total		**53**

Programme Elective Courses (PE)

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	PRPE10	Rapid Product Development	PRPC11, PRPC14, PRPC19	3
2.	PRPE11	Product Development Strategies	-	3
3.	PRPE12	Design for Manufacture and Assembly	PRPC16	3
4.	PRPE13	Finite Element Methods for Engineers	PRPC10	3
5.	PRPE14	Concepts of Engineering Design	PRPC19	3
6.	PRPE15	Engineering Optimization	PRPC16	3
7.	PRPE16	Computational Fluid Dynamics	PRPC13	3
8.	PRPE17	Experimental Stress Analysis	PRPC10	3
9.	PRPE18	Supply Chain Management	PRPC22	3
10.	PRPE19	Plant Engineering	PRPC16	3
11.	PRPE20	Design and Analysis of Experiments	MAIRYY, PRPC16	3
12.	PRPE21	Lean Manufacturing	PRPC16	3
13.	PRPE22	Material Handling and Storage	PRPC16	3
14.	PRPE23	Sustainable Manufacturing	PRIR15	3
15.	PRPE24	Industry 4.0	---	3
16.	PRPE25	Integrated Materials Management	PRPE14	3
17.	PRPE26	Agile Manufacturing	PRPC16	3
18.	PRPE27	Industrial Robotics	PRPC18	3
19.	PRPE28	Unconventional Machining Processes	PRPC14	3
20.	PRPE29	Precision Engineering	PRPC14	3
21.	PRPE30	Manufacturing of Composite Materials	PRPC10	3
22.	PRPE31	Machine Tool Technology	PRPC14	3
23.	PRPE32	Non Destructive Testing	---	3

24.	PRPE33	Surface Engineering	PRPC10	3
25.	PRPE34	Processing of Polymeric Composites	PRPC10	3
26.	PRPE35	Introduction to Friction Composites	PRPC10	3
27.	PRPE36	Work Design and Facilities Planning	PRPC16	3
28.	PRPE37	Reliability and Maintenance Engineering	---	3
29.	PRPE38	Vibration and Noise Engineering	---	3
30.	PRPE39	Data Analytics	MAIRYY	3
31.	PRPE40	Numerical Methods for Engineers	---	3
32.	PRPE41	Product and Service Life Cycle Management	---	3

Open Elective Courses

Sl.No.	Course Code	Course Title	Prerequisites	Credits
1.	PROE10	Operations Management	---	3
2.	PROE11	Project Management	---	3
3.	PROE12	Value Engineering	---	3
4.	PROE13	Artificial Intelligence and Expert systems	---	3
5.	PROE14	Processing and Manufacturing of	---	3
6.	PROE15	Finite Element Methods for Engineers	---	3
7.	PROE16	Laser Materials processing	---	3
8.	PROE17	Digital Manufacturing for Industry 4.0	---	3
9.	PROE18	Micro and Nano Manufacturing Processes	---	3
10.	PROE19	Introduction to Friction Composites	---	3
11.	PROE20	Green Material Joining and Forming	---	3
12.	PROE21	Automobile component manufacturing	---	3

Essential Programme Laboratory Requirements (ELR)

Sl.No.	Course Code	Course Title	Pre-/Co-requisites	Credits
1.	PRLR10	Manufacturing Processes Lab.	PRPC11, PRPC14	2
2.	PRLR11	Weldability and Formability Lab.	PRPC11, PRPC14	2
3.	PRLR12	Metrology and Computer Numerical Control Machines Lab.	PRPC16, PRPC17	2
4.	PRLR13	Machine Drawing (CAD) and Cost Estimation	MEIR12	2
5.	PRLR14	Manufacturing System Simulation Lab.	PRPC20	2
6.	PRLR15	Mechatronics and Industrial Automation Lab.	PRPC18	2
7.	PRLR16	Advanced Manufacturing Lab.	PRPC24	2
8.	PRLR17	Industrial Engineering Lab.	PRPC22, PRPC23	2

Total	16

Minor Courses (MI)

Sl.	Course	Course Title	Prerequisites	Credits
1.	PRMI10	CAD, CAM and CAE	---	3
2.	PRMI11	Manufacturing Processes	---	3
3.	PRMI12	Unconventional Manufacturing Processes	---	3
4.	PRMI13	Quality Engineering	---	3
5.	PRMI14	Industrial Engineering and Management	---	3

Advanced Level Courses for B.Tech. (Honours)

Sl.No.	Course	Course Title	Prerequisites	Credits
1.	PRHO10	Tolerance Technology	---	4
2.	PRHO11	Robotics	---	4
3.	PRHO12	Intelligent Manufacturing Systems	---	4
4.	PRHO13	Total Quality Engineering	---	4
5.	PRHO14	Product Analysis and Cost Optimization	---	4
6.	PRHO15	Decision Support Systems	---	4
7.	PRHO16	Knowledge Management	---	3
8.	PRHO17	Product Life Cycle Management	---	3
9.	PRHO18	Technology Management	---	3
10.	PRHO19	Multi-Criteria Decision Making Techniques	---	3
11.	PRHO20	Advanced Optimization techniques	---	4
12.	PRHO21	Modeling of Manufacturing Processes	---	3
13.	PRHO22	Control of Manufacturing Processes	---	3
14.	PRHO23	Flexible Manufacturing Systems	---	3
15.	PRHO24	Lasers in Manufacturing	---	3

Course Structure

Course Category	Courses	No. of Credits	Weightage (%)
GIR (General Institute Requirement Courses)	22	50	31.25
PC (Programme Core)	15	49 – 55**	32.50
Programme Electives (PE) / Open Electives (OE)	14$	42	26.25

Essential Laboratory Requirements (ELR)	Maximum 2 per session up to 6th semester	16	10
Total		**160 ±3**	**100**
Minor (Optional)	Courses for 15 credits	15 Additional credits	-
Honours (Optional)	Courses for 15 credits	15 Additional credits	-

**Minimum of 4 programme core courses shall be 4 credits each

$Out of 14 elective courses (PE/OE), the students should study at least eight programme elective courses (PE)

GIR Courses

Sl. No.	Name of the course	Number of courses	Max. Credits
1.	Mathematics	3	10
2.	Physics	1 Theory	3
		1 Lab	2
3.	Chemistry	1 Theory	3
		1 Lab	2
4.	Industrial Economics and Foreign Trade	1	3
5.	English for Communication	1 Theory	2
		1 Lab	2
6.	Energy and Environmental Engineering	1	2
7.	Professional Ethics	1	3
8.	Engineering Graphics	1	3
9.	Engineering Practice	1	2
10.	Basic Engineering	2	4
11.	Introduction to computer Programming	1	3
12.	Branch Specific Course# (Introduction to the Branch of study)	1	2
13.	Summer Internship	1	2
14.	Project work	--	--
15.	Comprehensive viva	1	1
16.	Industrial Lecture	1	1
17.	NSS/NCC/NSO	1	Compulsory participation
Total		**22**	**50**

#Offered by Industrial Experts/Alumni of NITT

PROGRAMME CORE (PC)

PRPC10 Applied Mechanics

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations.
- To solve problems relating to pure and non-uniform bending, torsional deformation of bars.
- To understand the concept of buckling and be able to solve the problems related to isolated bars.

Review of Forces and Moments, Introduction to Equilibrium, Application of the Equations of Equilibrium, Friction, Forces and Moments Transmitted by Slender Members, Shear Force and Bending Moment Diagrams. Mechanics of Deformable Bodies.

Force-Stress-Equilibrium, Multiaxial Stress and Strain, Multiaxial Strain and Multiaxial Stress-strain Relationships, Linear Elasticity - Material Behaviour, Stress Transformations and Principal Stress, Stress and Strain Transformations, Failure of Materials.

Pure Bending, Moment-curvature Relationship, Beam Deflection, Symmetry, Superposition, and Statically Indeterminate Beams, Torsion and Twisting, Energy Methods.

REFERENCES:

1. R. C.Hibbeler, Mechanics of Materials (SI Edition), Pearson Prentice Hall, 9th Ed,
2. Crandall, S. H., N. C. Dahl, and T. J. Lardner, An Introduction to the Mechanics of Solids. 3rd ed. Tata McGraw Hill, 2017
3. Egor P Popov, "Engineering Mechanics of Solids", 2nd Edition, Prentice Hall of India., 2008.

COURSE OUTCOMES:

1. Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations.
2. Solve problems relating to pure and non-uniform bending, torsional deformation of bars.

3. Understand the concept of buckling and be able to solve the problems related to isolated bars.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓				✓	✓					✓
CO2	✓	✓		✓		✓	✓		✓			✓
CO3	✓	✓		✓		✓	✓					✓

PRPC11 Casting and Welding Technology

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To spotlight the fundamental concepts of manufacturing process.
- To make the student understand clearly how the different components are manufactured in the present scenario with the help of casting and welding processes.
- To aid the student in governing the input parameters in casting and welding processes for controlling the product quality.

Sand casting, Core making processes - Different Moulding and Casting Processes- Die Casting-Centrifugal Casting-Investment Casting-Continuous Casting-Squeeze Casting-. Gating System and its Design, Riser Design and its Placement Melting, Pouring and Fluidity, Solidification of Pure Metals and Alloys,

Casting defects - inspection and testing of castings - Manufacturing of Cast irons – and its types. Casting of complicated shapes: automotive components, casting of light alloys – Aluminum, Magnesium and Titanium alloys.

Arc welding power sources- Basic physics of arc - Different arc welding processes (SMAW, GTAW, GMAM, SAW, ESW and EGW)- soldering, Brazing and adhesive bonding – Types of joint Configuration-Types of welding position- Gas welding and Gas cutting.

Design of welded joints - Metal surfacing and spraying - thermal cutting processes – Resistance welding -Heat flow characteristics and metallurgical changes in fusion welding - Solid state welding processes - Radiant energy welding processes - hybrid (laser +GMAW/GTAW) welding process.

Inspection and testing of welded joints– welding Defects, Causes and Remedies- Destructive tests – Non-destructive testing techniques – surface treatments-safety aspects in welding- Emerging Advances in welding Processes.

REFERENCES:

1. P.L.Jain " Principles of foundry Technology" Tata Mc Graw Hill Publishers
2. Peter Beelay, "Foundry Technology" Butterworth-Heinemann Publishers, Oxford. 2001
3. H.S.Bawa "Manufacturing Technology-I" Tata Mc Graw Hill Publishers New Delhi, 2007.
   Dr.R.S.Parmer "Welding processes and Technology" Khanna Publishers.S.
4. V.Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co.Pvt. Ltd

COURSE OUTCOMES:

1. Describe fundamental concepts of manufacturing process
2. Understand the components manufactured using casting and welding processes.
3. Identify the input parameters in casting and welding processes for controlling the product quality.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓	✓			✓
CO2	✓	✓	✓			✓		✓	✓			✓
CO3	✓	✓	✓				✓	✓	✓			✓

PRPC12 Metallurgy and Materials Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To test materials through various testing methods to evaluate their properties.
- To conduct heat treatment processes for metals.

Art and science of metallurgy-structure of metals and alloys-phase and structural constitutions- Equilibrium diagrams.

Ferrous metals and alloys-Fe-Fe3C diagram-Effect of alloying elements in steel, Classification of ferrous alloys and their applications.

Heat treatment of steel-CCT diagram-Surface hardening process-Non Ferrous Metals Alloys- composition-properties and applications of copper, nickel, lead, tin, zinc, aluminium, Mg and Ti alloys-Heat treatment of Non Ferrous alloy-Non Metallic Metals and alloys-ceramic material- polymers-composite material – Nano-structured materials.

Testing of Materials-Non-Destructive Testing, Tensile testing, compression testing - Hardness Testing.

Testing of Materials-Impact testing, Fatigue testing, Creep, other related testing methods characterization of TEM, XRD, SEM.

Practice:

Microstructural study of carbon steels, Cast Iron Jominy end quench test – Heat Treatments on steels – Hardening – Annealing – Normalizing – Tempering, Demonstration on SEM/XRD.

REFERENCES:

1. Raghavan V, Physical Metallurgy - Principles and Practice, Prentice - Hall of India,2nd Edition, 2007.
2. Avner S.H., Introduction to Physical Metallurgy, Tata McGraw Hill,2nd edition, 2008
3. Dieter G. E., Mechanical Metallurgy, McGraw Hill Co- Koga, 1stEdition ,2002
4. Suryanarayana AVK, Testing of Metallic Materials,BS Publications,2nd Edition, 2007.

COURSE OUTCOMES:

1. Interpret microstructure of engineering materials and explain Equilibrium diagrams.
2. Classify ferrous alloys and their applications with respect to foundry and welding processes.
3. Understand heat treatment processes for alloys, non alloys & summarize testing methods like TEM, XRD, SEM.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓		✓						✓
CO2	✓	✓		✓		✓	✓		✓			✓
CO3	✓	✓				✓	✓					✓

PRPC13 Fluids and Thermal Engineering

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To understand fluid flows and thermodynamic principles
- To analyse I.C.Engines, Compressors and Turbines
- To understand refrigeration and air conditioning systems

Vapour Pressure - Pressure at a point its variation - Measurement with Piezo meter, manometers and gauges
Continuity equation in one dimension - Bernoulli's equation - Venturi meters and Orificie meters - Flow through pipes - Laminar Turbulent flow Major losses
Pumps - General principles of displacement and Centrifugal pumps - Efficiency and Performance Curves of Pumps - Cavitation in Pumps - Turbines - Efficiency - Governing of turbines

Laws of Thermodynamics-Basic concepts - first law of thermodynamics applied to closed and open systems - simple problems.
Second law of thermodynamics - concept of reversible process
Air standard cycles - Otto, diesel and dual cycles - I.C. engines, S.I. engines and CI engines
Reciprocating compressor - effect of clearance volume, single and multistage compressor - Volumetric efficiency - calculation of power requirement - gas turbines - open and closed cycle - intercooling, reheating and regenerative cycles Wankel engine.
Properties of steam: P – V, T - S and H - S diagrams- Rankine cycle, modifications to improve thermal efficiency – introduction to air conditioning and refrigeration - Introduction to conduction, convection and radiation

REFERENCES:

1. Kothandaraman, C.P. and Rudramoorthy, R., Basic Fluid Mechanics, New Age International, 1st Edition, 1999.
2. Nag,P.K. “Engineering Thermodynamics”, 3rd Edition, Tata McGraw Hill, 2005.
3. Kothandaraman, C.P. and Domkundwar, S. "A Course in Thermodynamics and Heat Engines", Part- I, SI units, 3rd Edition, DhanpatRai and Sons, 1993.
4. Nagarathnam, S. 'Fluid Mechanics', Khanna Publishers,New Delhi, 1995.
5. Bansal, R.K., Textbook of Fluid Mechanics and Hydraulic Machines,Lakshmi Publications, 9th Edition 2008.
6. Ganesan, V., "Internal Combustion Engine", Tata McGraw Hill, New Delhi, 2004.

COURSE OUTCOMES:

1. Understand properties of fluids.
2. Determine flow through hydraulics machines and pipes.
3. Apply thermodynamic laws in engineering applications.
4. Calculate power requirements of gas turbines and flow rates through nozzles.
5. Calculate thermal efficiencies of steam turbines.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓				✓	✓					✓
CO2	✓	✓		✓		✓	✓		✓			✓
CO3	✓	✓		✓		✓	✓					✓
CO4	✓	✓		✓		✓	✓					✓
CO5	✓	✓		✓		✓	✓					✓

PRPC14 Forming and Machining Technology

L	T	P	C
4	0	0	4

COURSE OBJECTIVES:

- To study metal forming techniques with design aspects and acquire knowledge about process behaviour.
- To impart the knowledge on metal cutting mechanics, cutting force, stress, strain etc, effect of process parameters
- To demonstrate the fundamentals of machining processes and machine tools.
- To develop knowledge and importance of metal cutting parameters, tool materials, cutting fluids and tool wear mechanisms

Elastic and plastic deformation of metals and alloys – material properties – fundamentals of plasticity – yield criteria
Fundamentals of metal working – temperature, strain rate in metal forming – cold working – theory and analysis of bulk forming processes – theory and analysis of sheet metal forming processes – tools and dies – unconventional forming processes
Introduction to machining and machine tools – tool geometry – mechanics of machining – chip formation – heat transfer mechanism and cutting and cutting temperature generation – tool materials – tool wear mechanism – tool life and control of tool wear – cutting fluids
Working principle – operations - process parameters - drilling - milling - grinding machines
Control of machining processes for machinability and surface characteristics – economics of machining – Environmental conscious machining processes
Course outcomes:

- Understand the effects of temperature, speed on metal forming process
- Understand the principle, procedure and applications of Bulk Metal Forming and Sheet Metal Forming
- Demonstrate understanding of metal cutting principles and mechanism
- Identify cutting tool geometry of single point and multipoint cutting tool

Reference Books

1. Dieter G.E., “Mechanical Metallurgy”, McGraw Hill, Co., S.I. Edition, 2001
2. Metal Forming: Mechanics and Metallurgy, Wiliam F. Hosford, Robert M, Cambridge University Press, 2007
3. Manufacturing Science, Amitabha Ghosh and Ashok Kumar Mallik, East-West Press, 2010
4. Nagendra Parashar, and Mittal, R.K, Elements of manufacturing processes, Prentice Hall of India Private Limited,1stEdition, 2003.
5. HajraChoudhury SK, Bose HK and HajraChoudhury AK, Elements of Workshop Technology, Vol. II, Media promoters and Publishers Pvt. Ltd. 12thEdition, 2007.
6. ASM Handbook Volume 16: Machining
7. H.M.T, Production Technology, Tata McGrawHill Publishing Co.Ltd, 1st Edition, 2008.

COURSE OUTCOMES:

1. Summarize the theory of metal cutting and compute cutting forces involved from Merchant's circle.
2. Recognize various parts of lathe list the accessories and explain various operations performed.
3. Explain the construction of drilling, boring, reaming and milling machines and explain operations performed.
4. Understand the effects of temperature, speed on metal forming process.
5. Understand the principle, procedure and applications of Bulk Metal Forming and Sheet Metal Forming.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓		✓						✓
CO2	✓	✓		✓		✓			✓		✓	✓
CO3	✓	✓				✓	✓					✓
CO4	✓			✓		✓						
CO5	✓			✓		✓						

PRPC15 Kinematics and Dynamics of Machines

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To understand the basic concepts of machines and machinery.
- To understand law of gearing.
- To understand all mechanisms of machines.
- To design various mechanisms of machines.
- To evaluate various mechanisms of machines.

Kinematic pairs, diagram and inversion - Displacement, velocity and acceleration analysis of planar linkages– static and dynamic analysis of simple mechanisms
Cam profile synthesis - Gears dynamic force analysis
Flywheel – fluctuation of energy and speed, Governors
Inertia forces and their balancing for rotating and reciprocating machines. Hydrodynamic and boundary lubrication in journal and thrust bearings.
vibration types - one degree – Two degrees of freedom systems – modal analysis

REFERENCES:

1. Shigley, J.E. and Uicker, J.J.,Theory of Machines and Mechanisms, OxfordUniversity Press, 3rd Edition, 2008.
2. Thomas Bevan, Theory of Machines, CBS Publishers. 3rd edition, 2008.
3. Rattan S.S., Theory of Machines, Tata McGraw Hill Pub Co, 2nd Edition, 2008.
4. Rao, J.S., and Dukkipati, R.V.,Mechanism and Machine Theory, Wiley Eastern Ltd., Second Edition 1992.
5. Ghosh A and Mallik A.K., Theory of Mechanisms and Machines, Affiliated EWP Pvt. Ltd, Third Edition,2003.

COURSE OUTCOMES:

1. Understand the basic concepts of machines and machinery.
2. Understand law of gearing.
3. Understand all mechanisms of machines.
4. Design various mechanisms of machines.
5. Evaluate various mechanisms of machines.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓		✓						
CO2	✓	✓		✓		✓					✓	
CO3	✓	✓				✓	✓					
CO4	✓					✓						
CO5	✓		✓	✓		✓			✓			✓

PRPC16 Metrology, Quality and Safety

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study the fundamentals of measurements and its application.
- To apply various measurement techniques to inspect and test products.
- To learn statistical tools for quality analysis.
- To study the various industrial safety measures.

Introduction to Measurement – objectives – classification of methods of measurements - Precision and Accuracy - Standards and their evolution -Types of errors in measurements – Limit gauging

Comparators – types – applications – Linear, angular and form measurements – Surface roughness methods of surface finish – Direct instrument measurements. Limits, fits and tolerances.

Screw Thread Measurement- Standard thread profiles, Effective diameter, Terminology of gear tooth – Gear measurement – Parkinson gear tester- Alignment testing of machine tools – Coordinate measuring machines – Machine vision – Nano measurements.

Introduction to quality assurance and quality control – statistical process control – control charts for variable and attributes - process capability studies - acceptance sampling - Quality System standard –TQM.

Safety - Importance of safety - Fundamental Concepts and Terms- Workers' Compensation - Product Liability - Hazards and their Control – safety regulations.

REFERENCES:

1. Jain R. K., "Engineering Metrology", Khanna Publications, 2010
2. Douglas C. Montgomery, "Introduction to Statistical Quality Control", Wiley Publications, 2004.
3. Roger L. Brauer, "Safety and Health for Engineers", John Wiley Sons, 2006
4. Gupta. I.C., "Engineering Metrology", DhanpatRai and Sons, 1997.
5. Beckwith G. Thomas, Roy D. Marangoni, John H. Lienhard V, "Mechanical Measurements 6th Edition" Pearson publications, 2006.
6. Raghavendra, NV, Krishnamurthy L, "Engineering Metrology and Measurements", Oxford Press, 2013

COURSE OUTCOMES:

1. Understand the fundamentals of measurements.
2. Practice the usage of measurement techniques.
3. use quality control tools.
4. Ascertain industrial safety measures.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓						✓			✓	✓
CO2	✓	✓				✓			✓		✓	
CO3	✓	✓			✓		✓	✓				
CO4	✓	✓				✓						

PRPC17 Computer Numerical Control (CNC) Systems

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To understand the concepts of numerical and computer numerical control systems, their elements, machine tools and programming.

Fundamentals of numerical control – NC and CNC - classification of NC/CNC systems – introduction to multi-axes machines, configurations, control strategies - role of NC / CNC in CAM – applications, benefits and limitations of NC/CNC – DNC - Adaptive Control: ACO and ACC systems.

Machine tool - components of CNC machine tool, drives and controls - automatic tool changers, automatic pallet changers, tool offsets and work offsets, high speed and precision machining concepts

Machine control unit – elements, functions - interpolators - types and stages of interpolation- principles of interpolation - interpolation schemes - stairs approximation, digital differential analyser, direct function calculation; DDA-hardware and software; software interpolators- feedback devices.

Part program and its elements- methods of programming – manual part programming, formats. codes and cycles-computer assisted part programming - custom macro - APT and its variations - FMS

REFERENCES:

1. Yorem Koren, Computer Control of Manufacturing systems, McGraw Hill, 1986.
2. Mikell P Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall Publications, 2007
3. P. Radhakrishnan, “Computer Numerical Control Machines”, New Central Book Agency(P) Ltd., India, 1998
4. Paul Ranky, “Fundamentals of Computer Integrated Manufacturing”, Prentice Hall Publications, 1991
5. Reinbold U, Blume C and Dilmann R, Computer Integrated Manufacturing. Technology & Systems, Marcel Dekker, 1985.

COURSE OUTCOMES:

1. Experience NC/CNC and programming of CNC systems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓				✓	✓

PRPC18 Industrial Automation and Mechatronics

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand hydraulic devices and their applications.
- To analyze the integrated product design.
- To generate electro-hydraulic, electro-pneumatic solutions.

Introduction to automation - need – hard and soft automation production system facilities-automation in production systems-automation principles and strategies-elements of automation-advanced automation functions-levels of automation.
Introduction –, principles and application of hydraulic, pneumatic, electric controls system – control theory
Hydraulic system, hydraulic components - pressure-flow-direction controls valves – proportional, servo, cartridge (logic) valves- accumulator, accessories. Hydraulic components symbols- Design and application of hydraulic circuits of machine tool, press, Mobile hydraulic.
Pneumatic system, pneumatic components - pressure-flow-direction controls valves - pneumatic components symbols- Design and application of pneumatic circuits of machine tool.
Semi automats-automats-transfer lines - automatic assembly - transfer devices and feeders- classifications and applications-job orienting and picking devices- setting of automats and transfer lines.
Introduction to mechatronics, mechatronics system, Microprocessors and their applications in automation, Sensors and actuators, PLC system, examples of mechatronics systems.

REFERENCES:

1. Michael J. Pinches and John G. Ashby, Power Hydraulics, Prentice Hall, 1989.
2. DudleytA.Pease and John, J. Pippenger, Basic Fluid Power, Prentice Hall, 1983.
3. Doeblin, E.O. Measurement Systems, McGraw Hill, 1995.
4. Mechatronics 3/e,W, Bolton (Addison Wesley, ISBN 981-235-874-9.
5. Geoffrey Boothroyd, Assembly Automation and Product Design,Hardcover , 1992.
6. Rexroth- hydraulic training manual.

COURSE OUTCOMES:

1. Understand hydraulic devices and their applications.
2. Analyze the integrated product design.
3. Generate electro-hydraulic, electro-pneumatic solutions.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓	✓	✓		✓		✓	✓		✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓

PRPC19 Design of Machine Elements

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To understand material properties, design process and various theories of failures
- To design various basic machine components
- To design new components based on design principles

Introduction to the design process, factor influencing machine design, mechanical properties of materials, direct stress, bending stress, torsional stress and variable stress in machine parts, theories of failure, stress concentration factor, factor of safety. Design of shafts based on bending moment, twisting moment, combined of bending and twisting moments, axial loads in addition to combined torsional and bending loads, rigidity and stiffness. Design of springs.
Belt and chain drives: selection of flat belt, V belt and chain drives. Design of couplings, keys and bearings.
Welded joints: types of joints, welding symbol and weld symbol and their representation, strength of welded joints subjected to various types of load. Riveted joints: types of joints, design of riveted joints for structure.
Design of spur and helical gears. Design of gear box: layout diagram, speed diagram, fixing number of teeth and module of gears.

REFERENCES:

1. Bhandari, V.B., “Design of Machine Elements”,Tata McGraw-Hill, 2007.
2. Prabhu, T.J. "Design of Transmission Elements", Mani Offset, Chennai, 2005.
3. Shigley, J.E. and Mischke, C.R. "Mechanical Engineering Design" Tata McGraw Hill, 2006.
4. Sharma, C.S. and Purohit, K. “Design of Machine Elements”, Eurasia Publishing House (P) Ltd, New Delhi, 2005.

COURSE OUTCOMES:

1. Understand the various theories of failures.
2. Design various machine components.
3. Design new components based on the design principles.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓	✓	✓		✓		✓	✓		✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓

PRPC20 Manufacturing System Simulation

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the role of simulation in decision making.
2. To develop and analyze simulation models for manufacturing system.
3. To understand the applications of probability in simulation.
4. To understand the methods for random number and variate generation.
5. To understand the statistical methods used for input and output modeling in simulation.

Introduction to Simulation - Components of a system, Types of models, Monte Carlo Simulation, Steps in simulation, applications -Discrete Event Simulation – components of DES -Time advance mechanism.

Introduction – probability mass function, probability density function, Statistical models –Discrete distributions – Bernoulli, Binomial, Poisson, Geometric- Continuous distributions –Normal, Uniform, Exponential Gamma, Triangular Empirical Distributions

Properties of random numbers- Random number generation techniques –, linear, additive congruential. Test for random numbers- uniformity, independence- Kolmogorov simronov test, chi square, poker test, autocorrelation test. Random variate generation-Inverse transform Acceptance rejection, convolution method.

Input Analysis Methods-Examples-Verification of simulation models- Validation of simulation models-Measure of performance and their estimation- Output Analysis Methods-Transient and steady state behavior – Evaluation of alternate system design – Simulation Based Optimization (SBO).

Introduction to role of simulation in Industry 4.0, agent based simulation, data analytics and AI in simulation, Emulation, Virtual reality and Augmented reality applications in manufacturing.

REFERENCES:

1. Jerry Banks and John S.Carson, Barry L Nelson, David M.Nicol, P.Shahabudeen, Discrete event system simulation, Pearson Education, 2007.
2. Law A.M, Simulation Modelling and Analysis, Tata Mc Graw Hill,2008
3. Virtual reality technology (2nd edn). Grigore C. Burdea and Philippe Coiffet, Wiley, New York, 2003. No. of pages: xvi+444. ISBN 0-471-36089-9
4. Thomas J.Schriber, Simulation using GPSS, John Wiley, 1991.
5. Kelton, W. David, Simulation with Arena ,McGraw-Hill,2006

COURSE OUTCOMES:

1. Understand the role of simulation in decision making.
2. Develop and analyze simulation models for manufacturing system.
3. Understand the applications of probability in simulation.
4. Understand the methods for random number and variate generation.
5. Understand the statistical methods used for input and output modeling in simulation.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓	✓	✓			✓	✓
CO2	✓	✓		✓	✓		✓		✓		✓	
CO3	✓	✓		✓	✓		✓				✓	
CO4	✓	✓		✓	✓		✓				✓	
CO5	✓	✓		✓	✓		✓				✓	

PRPC21 Manufacturing Tooling and Automated Inspection

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To identify the elements and its potential of Tooling in manufacturing.
- To design and Develop Tooling for Casting Welding Forming and Machining.
- To design and development of Automation systems for Inspection.

Introduction: Manufacturing Processes-objectives of manufacturing processes-classification of manufacturing process-Objectives of Tool design-Tool design process- Tool engineering principles Tooling economics-Tool planning – tool materials and its selection

Tooling for Metal Casting and Metal Joining Processes: Tools and Equipment for molding-patterns –pattern allowances – pattern construction-die casting tools-mechanization of foundries. Tooling for Physical joining processes Design of welding fixtures – Arc welding, Gas welding, Resistance welding, laser welding fixtures-Tooling for Soldering and Brazing Tooling for Mechanical Joining processes – assembly fixtures

Tooling for Metal Forming Processes: Classification of Forming processes-Types of presses-design of -blanking and piercing dies-simple, compound, combination and progressive dies-Drawing dies-Bending dies-Forging dies-plastic Moulding dies

Tooling for Metal Removal Processes: - Traditional machining processes -work and tool holding devices-tool nomenclatures- Mechanism of machining- force temperature and tool life of single point tool-multipoint tools -tool design- tool wear- special processes-capstan and turret lathe- tooling layout of automats-tooling in NC and CNC machines-tooling for Machining centres-Jigs and fixtures-design – modular fixtures

Tooling for Inspection and Gauging: Survey of linear and angular measurements-Comparators-Types of Limit Gauges-Design and Manufacturing of Limit gauges-Measurement of Form-Inspection bench center-Co-ordinate measuring machine-Tooling in CMM. Flexible and Automated inspection systems - introduction to tooling for robotics.

REFERENCES:

1. Kalpakjian S., Manufacturing Engineering and Technology Addison Wesley 1995
2. Hoffman E.G Fundamentals of tool design SME 1984.
3. Venkataraman K Design of jigs, fixtures and press tools , Wiley Publications
4. Sharma,P C "A Text Book of Production Engineering", S.Chand & Company Ltd.,
5. Donaldson, C., "Tool Design", Tata MeGraw Hill Pub.Co.,
6. Pham D T and Alcock R J Smart Inspection Systems ACADEMIC PRESS
7. Stanley L. Robinson, Richard Kendall Miller Automated Inspection and Quality Assurance 1989 CRC Press

COURSE OUTCOMES:

1. State of Art in Tooling in Manufacturing and Inspection
2. Design and Develop tooling for Manufacturing
3. Design and Develop Automated Inspection Systems

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓	✓	✓		✓		✓	✓		✓	✓
CO3	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓

PRPC22 Operations Research

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To understand Linear programming, assignment and queuing problems
- To make decisions under uncertainty
- To prepare project network and perform project scheduling

Concept of linear programming model-Development of LP models - Graphical method. Simplex method - Big M method - Two-phase method - Special cases in Linear Programming. Introduction to duality theory.

Introduction-Mathematical model for Transportation problem –balanced and unbalanced transportation problem. Methods to solve transportation problem-finding basic feasible solution- testing solution for optimality - Assignment problem-unbalanced assignment problem- maximisation problem-problem with assignment restrictions. Travelling sales man problem.

Introduction-characteristics of queuing problem-terminologies of queuing problem-applications of queuing model -single server model. Simulation-need for simulation-Random number generation-methods. Applications of simulation-maintenance, queuing and inventory. Line balancing.

Decision under Uncertainty-Laplace criterion, Maximin criterion, minimax criterion, Savage minimaxregrert criterion, Hurwicz criterion. Decision making under risk-expected value criterion- decision tree, Investment decisions –present worth method, annual equivalent method, rate of return method, Replacement Analysis-types of replacement problem. Replacement of item that fail with respect to time. Replacement of item that fail suddenly-individual replacement and group replacement.

Project network construction – Critical Path Method (CPM) - determination of critical path - Project Evaluation and Review Technique (PERT)-probability of completing a project in a scheduled date - Crashing of project network-cost considerations in project scheduling.

REFERENCES:

1. Gupta, P.K. and Hira, D.S, Operations Research, 3rd Edition, S.Chand and Company Ltd., New Delhi, 2008.
2. Taha H.A, Operations research,Prentice – Hall of India, New Delhi, 8th Edition, 2006.
3. Panneerselvam, R, Operations Research,Prentice – Hall of India, 2nd Edition, New Delhi, 2006.

COURSE OUTCOMES:

1. Summarize different techniques for production planning like queuing uncertainty and mathematical modeling are involved.
2. Apply optimization in utilization of resources.
3. Apply resource management techniques to industrial operations.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓	✓	✓		✓	✓				✓	✓
CO3	✓	✓	✓	✓		✓					✓	✓

PRPC23 Analysis of Production Systems

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To understand production function, Design of Product, Planning functions, Material Planning and Layout and Scheduling.

Engineering Economy and Costing: Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments.
Basics of product management – Forecast models, errors, tracking signals. Inventory costs – types of systems – policies – analysis & static models.
Concept of capacity and aggregate production planning – strategies – charting techniques – master production scheduling.
MRP concepts – problems – lot sizing – techniques - Push and pull production systems – concept of JIT manufacturing systems.
Scheduling concepts – various types of scheduling – methods and tools to solve scheduling problems.

REFERENCES:

1. Buffa, E.S., "Modern Production/Operations Management", 8th edition, John Wiley sons, 2003.
2. Elsayed A Elsayed, Thomas O. Boucher, “Analysis and control of Production System”, Prentice Hall, 2002.
3. Ehud Menipaz, “Essentials of Production and Operations Management”, Prentice-Hall, 1984.
4. Panneerselvam, R. “Production and Operations Management”, PHI Learning Private Limited, 2012.
5. Chary, S.N., “Production and Operations Management”, McGraw Hill Education (India) Private Limited, 2012.
6. Monks J.G. Operations Management, McGraw Hill, 2004.
7. Norman Gaither, Greg Frazier, Operations Management, Thomson Learning, 9th Edition, 2002.

COURSE OUTCOMES:

1. Forecast Production functions.
2. Enhance Planning of Product Design and Service Operations.
3. Facilitate Planning and Project Management.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓		✓		✓					✓	✓
CO3	✓	✓	✓	✓		✓	✓				✓	✓

PRPC24 Computer Aided Design and Rapid Prototyping

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To realize basics of geometric modelling and transformation techniques
- To understand exchange standards and Rapid Prototyping processes
- To explore applications of CAD and Rapid Prototyping

Fundamentals of CAD Interactive graphics - point plotting techniques. Transformations techniques, viewing operations: window, viewport and clipping,
Visual realism: Hidden line/surface removal, shading and colour models. Geometric modeling: Wireframe modeling, Surface modeling: Representation of curves and surfaces, Design of curves: cubic splines, Bezier curves and B-spline, design of surfaces.
Solid modeling: Constructive solid geometry (C-rep) and Boundary representation (B-rep). Graphics standards: GKS, and IGES standards, STEP - Parametric design programmes. Applications of CAD.
Overview on Rapid Prototyping, Classification of Rapid Prototyping processes, STL file format.
Principle, process details and applications of Stereo lithography systems, Selective Laser Sintering, Solid Ground Curing, Laser Engineered Net Shaping.
Process details and applications of Fused Deposition Modeling, Binder Jetting, Laminated Object Manufacturing, 3D Printing.

REFERENCES:

1. Anand, V.B., Computer Graphics and Geometric Modeling for Engineers, John Wiley and Sons, Inc., 2000.
2. Zeid,I and Sivasubramanian, R., CAD/CAM- Theory and Practice, Tata McGraw-Hill, 2018 (23rd Reprint).
3. Pham D T and Dimov S S, "Rapid Manufacturing", Verlag, 2001.
4. Paul F Jacobs, "Stereo lithography and other RP&M Technologies", SME, 1996.

COURSE OUTCOMES:

1. Recognize the fundamentals and concepts of CAD.
2. Competence on surface and solid modelling.
3. Understand on principles and applications of Rapid Prototyping processes.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓		✓	✓	✓					✓	✓
CO3	✓	✓	✓	✓		✓	✓				✓	✓

Essential programme laboratory Requirement (ELR)

PRLR11 Manufacturing Processes Lab

L	T	P	C
0	0	3	2

COURSE OBJECTIVES:

- To provide the in depth knowledge of the types of machining processes, evolution and need.
- To acquire the hands on experience and skills for various turning operations, milling operations, shaping, drilling, gear cutting, slotting and grinding machines.

EXERCISE-1: Step turning
EXERCISE-2: Taper turning and parting off
EXERCISE-3: Knurling
EXERCISE-4: Thread cutting
EXERCISE-5: Boring
EXERCISE-6: Eccentric turning
EXERCISE-7: Copy turning
EXERCISE-8: Shaping rectangular block or cube
EXERCISE-9: Slot cutting/ Step-cutting/ V-lock
EXERCISE-10: Milling rectangular block or cube
EXERCISE-11: T -Slot milling
EXERCISE-12: Spur gear cutting
EXERCISE-13: Surface grinding
EXERCISE-14: Single point tool grinding
EXERCISE-15: Spur and Helical gear generation on hobbing machine
EXERCISE-16: Complex shaped component production using EDM.
EXERCISE-17: Drilling
EXERCISE-18: Fabrication of Polymeric based Product and Near net shape product manufacturing

COURSE OUTCOMES:

1. Enhance the skills in machining operations like turning, milling, shaping, grinding, slotting and gear cutting.
2. Design and development of experimental apparatus of any manufacturing process. Perform good workplace ethics in completing assigned projects as directed.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓	✓			✓		✓

CO2			✓		✓			✓	✓	✓	✓	

PRLR12	Weldability and Formability Lab.	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- To Weld materials effectively and evaluate the performance of the weldment.
- To test sheet metals and evaluate their properties.

WELDING LAB EXERCISES:

1. Arc butt welding of mild steel.
2. Macrostructure and microstructure of nugget zone.
3. Hardness test on weldments.

COURSE OUTCOMES:

1. Application of welding knowledge to fabricate sound parts.
2. Application of testing knowledge to evaluate the quality of weldments.

FORMABILITY TESTING LAB

PREREQUISITE COURSES: Metallurgy and Materials Engineering

COURSE OBJECTIVES:

- To test the formability of sheet metals

LAB EXERCISES

1. Tensile testing
2. Three-point bend test
3. Deep drawing test

COURSE OUTCOMES:

1. Weld different materials and evaluate the performance of the weldment.
2. Evaluate formability of sheet metals.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓	✓		✓		✓	
CO2	✓	✓	✓		✓	✓	✓		✓		✓	

PRLR13	Metrology and Computer Numerical Control Machines Lab.	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- To utilize various measuring instruments for basic and advanced measurements.
- To perform basic metal cutting operations by CNC machines.

METROLOGY LAB:

Study and use of Electronic comparator - Profile projector - sine bar - precision measuring instruments - coordinate measuring machine - Measurement of Gear tooth thickness - Adjacent base pitch error - surface roughness – statistical process control exercises.

COMPUTER NUMERICAL CONTROL MACHINES LAB:

1. Plain turning and facing operations on EMCO turning machine.
2. Step turning operation on LEADWELL machine.
3. External threading operation on LEADWELL and STC 15 machines.
4. Profile milling operation on VMC machine.
5. Circular pocketing/ rectangular pocketing /drilling operations on EMCO milling machine.
6. Mirroring operation on MTAB milling machine.
7. Inspection on CMM

COURSE OUTCOMES:

1. Utilize various measuring instruments for basic and advanced measurements.
2. Perform basic metal cutting operations by CNC machines.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓	✓			✓		✓	
CO2	✓		✓	✓	✓	✓	✓		✓		✓	

PRLR14	Machine Drawing CAD and Cost Estimation	L	T	P	C
		1	0	2	2

COURSE OBJECTIVES:

- To prepare the precise machine drawings for manufacture of components.
- To facilitate better product design.
- To interpret and generate suggestions about drawings.
- To estimate cost for production.

Conventions, Abbreviations and symbols: Conventional representations of interrupted views, symmetrical objects, intersection curves, square ends and openings, adjacent parts, common machine elements, springs, gear drives–Abbreviations, designation and composition of ferrous materials, nonferrous materials and engineering drawing.
Limits, Fits and Tolerances, tolerance grades, fundamental deviation, indication of tolerances- classification, system, selection and indication of fits, geometrical tolerances, surface texture.
Screw threads and threaded fasteners, types of bolts and nuts, locking pins, screws. Rivet joints, Keys and welded joints.
Assembly Drawing: Cotter and pin joints, couplings, clutches, pulleys and pipe joints.
Assembly Drawing: Bearings, heat engine parts, valves, pumps and machine parts.
Cost Estimation: Preparation of Process chart for a given component-estimation of setting time and machining time-estimation of material cost, labour cost and overhead cost based on supplied data-Kaizen Costing-Activity Based costing-Lifecycle costing.

REFERENCES:

1. David Allan Low, An Introduction to Machine Drawing and Design, Andesite Press, ISBN-13: 978-1375955713.
2. Gregory K. Mislick, Daniel A. Nussbaum, Cost Estimation: Methods and Tools (Wiley Series in Operations Research and Management Science), ISBN-13: 978-1118536131 Wiley-Blackwell; 1 Edition, 2015.
3. Gopalakrishna, K. R., Machine Drawing, Subhas stores, Bangalore, 16th Edition, 2002.
4. Varghese, P. L. and John, K.C., Machine Drawing, Jovast Publishers, 1993.
5. BIS, SP:46 -1988 - Engineering Drawing Practice for Schools and Colleges, 1992.
6. Faculty of Mechanical Engineering, PSG College of Technology, Design Data Book, M/s.DPV Printers, Coimbatore, 1993.

COURSE OUTCOMES:

1. Prepare the precise machine drawings for manufacture of components.
2. Facilitate better product design.
3. Interpret and generate suggestions about drawings.
4. Estimate cost for production.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓			✓		✓	
CO2	✓		✓		✓	✓			✓		✓	
CO3	✓		✓		✓	✓			✓		✓	
CO4	✓					✓	✓		✓		✓	

PRLR15 Manufacturing System Simulation Lab.

L	T	P	C
0	0	3	2

COURSE OBJECTIVES:

- To understand the role of simulation in decision making.
- To develop and analyze simulation models for manufacturing and service system.
- To analyse the outcome and offer suggestions for improvement.

LIST OF EXERCISES:

1. Simulation of Manufacturing Shop
2. Simulation of Multiple Servers Queuing System
3. Simulation of Supply Chain Inventory System
4. Simulation of Batch Production System
5. Simulation of Multi Machine Assignment System
6. Simulation of Manufacturing and Material Handling Systems
7. Simulation of a Shop Floor
8. Simulation of Material Handling Systems
9. Simulation of healthcare system

COURSE OUTCOMES:

1. Understand the role of simulation in decision making.
2. Develop and analyze simulation models for manufacturing and service system.
3. Analyse the outcome and offer suggestions for improvement.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓				✓			
CO2	✓	✓		✓	✓	✓			✓			
CO3	✓	✓	✓	✓	✓	✓			✓			

PRLR16 Industrial Automation and Mechatronics Lab.

L	T	P	C
0	0	3	2

COURSE OBJECTIVES:

- To Learn and simulate Hydraulic, Pneumatic, Electro Hydraulic and Electro Pneumatic circuits.
- To Understand and simulate PLC circuits for fluid power control system.
- To Learn, generate and understand Robot programming.

LAB EXERCISES:

1. Design, simulate and testing of Pneumatic and Electro Pneumatic circuits for engineering applications using actuators and control valves (pressure, flow and direction).
2. Design, simulate and testing of Hydraulic and Electro Hydraulic circuits for engineering applications using actuators and control valves (pressure, flow and direction).
3. Design, simulate and testing of PLC circuits for engineering applications using sensors.
4. Using MAT Lab/ SCI lab -Study on Robot programming and operation with vision systems

COURSE OUTCOMES:

1. Design Hydraulic, Pneumatic, Electro Hydraulic and Electro Pneumatic circuits for industrial automation.
2. Design and simulate PLC circuits for industrial automation.
3. Generate robot programming for industrial automation.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓			✓			✓		✓	
CO2	✓		✓			✓			✓		✓	
CO3	✓		✓		✓	✓	✓		✓			

PRLR17 Advanced Manufacturing Lab.

L	T	P	C
0	0	3	2

COURSE OBJECTIVES:

- To have real time experience on rapid prototyping processes.
- To have real time experience on tribological and advanced fabrication tests.
- To study the advanced fabrication process- Ultrasonic Welding, Microwave welding and Fusion bonding process to manufacture product.

List of Exercises

RAPID PROTOTYPING

1. Generation and Analysis of Stl files / Development of CAD model from scan data (using 3D Scanner)
2. Study of 3D Printer architecture, Demonstration on software for 3D Printer and analysis of process parameters
3. Development of Prototypes using 3D Printer
4. Life Cycle Assessment of 3D Printed parts

SURFACE ENGINEERING

1. Pin-on-disc based tribological characterization of materials at different load conditions with constant sliding speed.
2. Pin-on-disc based tribological characterization of materials at different sliding speeds with constant load.
3. Measurement of bonding strength of coating using Scratch Tester.
4. Measurement of surface roughness using 3D Non-Contact Profilometer.
5. Exercise on tribo-corrosion using corrosive wear monitor.

ADVANCED FABRICATION TECHNIQUES

1. Experimental investigation on Application of Ultrasonic Processing method on Advanced materials and investigate it process parameters.
2. Study on Application of Microwave Processing method on Advanced materials and investigate it process parameters.

3. Study on Fusion Bonding Process on Advanced materials and investigate it process parameters.
4. Study on Frictional Vibration Joining on Advanced materials and investigate it process parameters.

COURSE OUTCOMES:

1. Apply rapid prototyping processes for fabricating standard products.
2. Characterize samples through tribological and advanced fabrication tests.
3. Apply Advance Fabrication Process to develop Product.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓	✓			✓		✓	
CO2	✓		✓	✓	✓	✓			✓		✓	
CO3	✓		✓	✓	✓	✓			✓		✓	

PRLR18 Industrial Engineering Lab.

L	T	P	C
0	0	3	2

COURSE OBJECTIVES:

- To apply forecasting methods for industrial engineering problems.
- To apply different methods for scheduling problems.
- To apply inventory model - a case study.
- To use Barnes Peg Board in an experiment and to have time study training.

1. Forecasting Method – Simple Moving Average
   – Weighted Moving Average
   – Exponential Smoothing
2. Scheduling Problem - Shortest Processing Time
   - Earliest Due Date
   - Johnson's Method
3. Inventory Model - EOQ with Service Level
   – EOQ

– Fixed Time Period

4. Material Requirement Planning
5. Barnes Peg Board Experiment
6. Time Study Trainer
7. Performance Rating (Walking)

COURSE OUTCOMES:

1. Apply forecasting methods for industrial engineering problems.
2. Apply different methods for scheduling problems.
3. Apply inventory model for a case study.
4. Use Barnes Peg Board in an experiment and learn time study.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓	✓			✓		✓	
CO2	✓		✓	✓	✓	✓			✓		✓	
CO3	✓		✓	✓	✓	✓			✓		✓	
CO4	✓		✓	✓	✓	✓			✓		✓	

PROGRAMME ELECTIVE (PE)

PRPE10 Rapid Product Development

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand advancements in rapid manufacturing
- To gain competence on rapid product development
- To recognize industrial applications of rapid product development

Overview of Rapid Product Development: Product Development Cycle, Definition of Rapid Product Development, Overview on Solid, Liquid and Power based processes, Virtual prototypical and rapid manufacturing technologies.

Rapid Tooling: Introduction to Rapid Tooling, Indirect Rapid Tooling Processes, Direct Rapid Tooling Processes, Emerging Trends in Rapid Tooling, Design for Additive Manufacturing.

Advances and Trends in Rapid Manufacturing – Light weighting - 4D Printing, Metal based Printing, Friction based process, Hybrid Layered Manufacturing, Segmented Object Manufacturing, Rapid Casting

Selection of a suitable Rapid Manufacturing process for a given application, Criteria for Technology selection – Problem formulation – Sustainable Rapid Manufacturing – Life Cycle Assessment

Applications and Case Studies: Engineering Applications, Medical Applications, Industrial applications, Modelling aspects and STL files, Modelling and Optimization for Rapid Manufacturing, Scope of Rapid Manufacturing research centers.

REFERENCES:

1. Pham D T and Dimov S S, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer, 2011.
2. Paul F Jacobs, "Stereo lithography and other RP&M Technologies", SME, 1996.
3. C.K. Chua K.F. Leong, and C.S. Lim, “Rapid Prototyping: Principles And Applications”, World Scientific Publishing, 2008
4. M. Adithan, “Rapid Product Development”, New Age International Private Limited (1 January 2015
5. Terry Wohlers, "Wohlers Report 2001", Wohlers Associates, 2008.
6. Jing Zhang and Yeon-Gil Jung, “Additive Manufacturing: Materials, Processes, Quantifications and Applications”, Butterworth-Heinemann; 1 edition (17 May 2018)
7. Karl Ulrich and Steven Eppinger, “Product Design and Development”, McGraw Hill Education, 2017

COURSE OUTCOMES:

1. Understand advancements in rapid manufacturing
2. Competence on rapid product development
3. Recognize industrial applications of rapid manufacturing

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓									
CO2	✓	✓	✓	✓	✓	✓		✓	✓		✓	
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓

PRPE11 Product Development Strategies

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the complexities in product development
- To gain knowledge on tools/techniques of product development
- To recognize the need for design to suit environment

Product development versus design, types of design and redesign, modern product development process, reverse engineering and redesigning product development process, examples of product development process, scoping product development – S-curve, new product development.

Gathering customer needs, organizing and prioritizing customer needs, establishing product function, FAST method, establishing system functionality.

Tear Down and Experimentation- Tear down method, post teardown report, benchmarking and establishing engineering specifications, product portfolios.

Generating Concepts- Information gathering, brain ball, C-sketch/6-3-5 method, morphological analysis, concept selection, technical feasibility, ranking, measurement theory, DFMA, design for robustness

Design for the Environment: DFE methods, life cycle assessment, weighted sum assessment method, techniques to reduce environmental impact – disassembly, recyclability, remanufacturing regulations and standards, analytical and numerical model solutions.

REFERENCES:

1. Kevin Otto and Kristin Wood, “Product Design – Techniques in Reverse Engineering and New Product Development”, Pearson Education, 2004.
2. Karl T Ulrich and Stephen D Eppinger, “Product Design and Development”, McGraw Hill, 1994.

COURSE OUTCOMES:

1. Explain modern product development process.
2. Design for the Environment through DFE method life cycle assessment.
3. Gather customer needs.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						
CO2	✓	✓		✓		✓						

CO3	✓					✓						

PRPE12 Design for Manufacture and Assembly

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To identify opportunities for design.
- To address technical considerations of design and manufacturing.
- To utilize DFM and Concurrent Engineering Principles on a "real life" project.

Engineering design – Kinds of design – Design process steps – Factors influencing design – Concurrent Engineering – Material selection process – Evaluation methods for material selection

Process capability analysis – Cumulative effect of tolerances – Centrality analysis – Compound assembly – Selective and Interchangeable assembly – Grouped Datum systems

Design for castings – Design for weldments – Design for forgings – Design for sheet metal formed parts – Design for powder metallurgy parts – Design for plastic parts

Design for machining – Design for economy – Design for clampability – Design for ease of assembly – Design for disassembly

Advances in DFMA- Design for robustness – Axiomatic design – Design for environment – DFA index – Poka Yoke – Lean principles – Six sigma concepts – Computer aided DFA using software.

REFERENCES:

1. Dieter, G.E., Engineering Design: A Materials and processing Approach, McGraw Hill Co. Ltd, 2000.
2. Boothroyd, G., Assembly, Automation and product design, CRC press, 2005.
3. Eggert, R.J., Engineering Design, Pearson Education, Inc. New Jersey, 2005.
4. KalandarSaheb, S.D and Prabhakar, O., Engineering Design for Manufacture, ISPE 1999. 3Boothroyd, DFMA.

COURSE OUTCOMES:

1. Identify opportunities for design.
2. Address technical considerations of design and manufacturing.
3. Utilize DFM and Concurrent Engineering Principles on a "real life" project.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓		✓						✓

CO2	✓	✓	✓	✓		✓						✓
CO3	✓	✓	✓	✓		✓						✓

PRPE13 Finite Element Methods for Engineers

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the need in Design for the Finite Element Method
- To tie his/her understanding of mechanical engineering design concepts to use the Finite Element Method software correctly and efficiently
- To analyze a physical problem, develop finite element procedures for accurately investigating the problem, and effectively perform and document findings

Introduction, Calculus of Variations, Approximate methods for solving differential equations, Ritz and Galernkin FEM formulations

One dimensional FEM formulations, bending of beams, trusses and Frames.

Two dimensional problems, Heat transfer, fluid flow and torsional problems

Numerical integration, Plane stress and plane strain problems. Free vibration problems, Time history problems

Introduction to non-linear FE Methods. Error analysis in FEM, Developing FEM code

REFERENCES:

1. US Dixit, Finite Element Methods for Engineers, Cengage Learning Asia; 1st edition, 2009.
2. M.Asghar Bhatti, “Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations”, Wiley; 1 edition, 2003
3. Bathe KJ, “Finite Element Procedures”, Prentice Hall, 1994

COURSE OUTCOMES:

1. Understand the numerical methods involved in Finite Element Theory and its direct/indirect methods.
2. Understand the formulation of one dimensional and two dimensional elements for structural, heat transfer and flow problems.
3. Perform and verify FEA using commercial FEA software.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	✓			✓								
CO2	✓			✓								
CO3	✓			✓	✓	✓						✓

PRPE14 Concepts of Engineering Design

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study about fundamental design standards and needs
- To learn about human and product factors involved in design concepts and rapid prototyping methods

DESIGN FUNDAMENTALS: Importance of design- The design process- Considerations of Good Design –Morphology of Design –Organization for design– Computer Aided Engineering – Designing to codes and standards – Concurrent Engineering – Product and process cycles – Technological Forecasting – Market Identification – Competition Bench marking.

CUSTOMER ORIENTED DESIGN & SOCIETAL CONSIDERATIONS: Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics. Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics – Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society.

DESIGN METHODS: Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design-Product Architecture Configuration Design-Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping- Finite Element Analysis– Optimization – Search Methods.

MATERIAL SELECTION PROCESSING AND DESIGN: Material Selection Process – Economics – Cost Vs Performance – Weighted property Index – Value Analysis – Role of Processing in Design – Classification of Manufacturing Process – Design for Manufacture – Design for Assembly –Designing for castings, Forging, Metal Forming, Machining and Welding Residual Stresses – Fatigue, Fracture and Failure.

PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY: Probability – Distributions - Test of Hypothesis – Design of Experiments – Reliability Theory – Design for Reliability – Reliability centered Maintenance-Robust design – FMEA.

REFERENCES:

1. Dieter, George E., “Engineering Design - A Materials and Processing Approach”, McGraw Hill, International Editions, Singapore, 2000.
2. Suh, N.P., “The principles of Design”, Oxford University Press, NY.1990.
3. Karl T. Ulrich and Steven D. Eppinger “Product Design and Development” McGraw Hill Edition 2000.

COURSE OUTCOMES:

1. Demonstrate fundamental design standards and customer needs.
2. Understand human and product factors involved in design concepts.
3. Apply engineering design concepts.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓		✓						
CO2	✓											
CO3	✓	✓	✓	✓	✓	✓						

PRPE15 Engineering Optimization

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand and apply the various Traditional optimization techniques to solve engineering problems.
- To understand and apply the various Non Traditional optimization techniques to solve engineering problems.

Introduction: Introduction to engineering optimization - General principles – Classification - Problem formulation & their classifications

Classical optimization techniques: Single variable and multivariable optimization-Single and Multi objectives-Pareto Optimal solutions.

Unconstrained Optimization Techniques: Techniques of unconstrained optimization – Golden section, Random, Pattern and Gradient search methods – Interpolation methods.

Constrained Optimization Techniques: Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions.

Unconventional Optimization Techniques: Genetic Algorithms, Particle Swarm Optimization, Simulated Annealing and Ant Colony algorithm.

REFERENCES:

1. S.S. Rao, “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2009.
2. Kalyanamoy Deb, “Optimization for Engineering Design Algorithms and Examples”, Prentice Hall of India Pvt. Ltd., 2006.
3. C. Johnson Ray, “Optimum Design of Mechanical Elements”, Wiley, John & Sons,Digitized 2007.
4. D.E.Goldberg, “Genetic Algorithms in Search, Optimization and Machine”, Barnen, AddisonWesley, New York, 1989.
5. C.S.Rao, “Optimization Techniques”, DhanpatRai& Sons, New Delhi

COURSE OUTCOMES:

1. Solve engineering problems using Traditional optimization techniques.
2. Solve engineering problems using Non-Traditional optimization techniques.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓						✓

CO2	✓	✓	✓	✓	✓	✓						✓

PRPE16 Computational Fluid Dynamics

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To perform numerical modelling and its role in the field of fluid flow and heat transfer
2. To use various discretization methods, solution procedures and turbulence modelling to solve flow and heat transfer problems.

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS: Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION: Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three – dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

FINITE VOLUME METHOD FOR CONVECTION DIFFUSION: Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

FLOW FIELD ANALYSIS: Finite volume methods -Representation of the pressure gradient term and continuity equation –Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

TURBULENCE MODELS AND MESH GENERATION: Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

REFERENCES:

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition, 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
3. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation,2004.
4. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
5. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
6. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
7. ProdipNiyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
8. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.

COURSE OUTCOMES:

1. Perform numerical modelling and its role in the field of fluid flow and heat transfer.
2. Use various discretization methods, solution procedures and turbulence modelling to solve flow and heat transfer problems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓						✓
CO2	✓	✓	✓	✓	✓	✓						✓

PRPE17 Experimental Stress Analysis

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand stress strain analysis with its relation
2. To recognize materials structure and testing methods

Overview of Experimental Stress Analysis- Optical Methods Work as Optical Computers- Stress, Strain and Displacement Fields- Physical Principle of Strain Gauges, Photo elasticity and Moiré- Introduction to Moiré, Brittle Coatings and Holography- Hologram Interferometry, Speckle Methods- Introduction to Shearography, TSA, DIC and Caustics- Fringe Patterns – Richness of Qualitative Information

Multi-Scale Analysis in Experimental Mechanics- Selection of an Experimental Technique- Introduction to Transmission Photo elasticity- Ordinary and Extraordinary Rays- Light Ellipse, Passage of Light Through a Crystal Plate- Retardation Plates, Stress-optic Law- Plane Polariscope- Jones Calculus

Circular Polariscope-Determination of Photoelastic Parameters at an Arbitrary Point-Tardy's Method of Compensation-Calibration of Photo elastic Materials-Fringe Thinning Methodologies Photo elasticity Ordering Fringe in Miscellaneous-Topics in Transmission Photoelasticity -Three Dimensional Photoelasticity

Overview of Digital Photo elasticity-Introduction to Photoelastic Coatings-Correction Factors for Photoelastic Coatings-Coating Materials, Selection of Coating Thickness, Industrial Application of Photoelastic Coatings-Calibration of Photoelastic Coatings, Introduction to Brittle Coatings-Analysis of Brittle Coatings -Introduction to Strain Gauges-Strain Sensitivity of a Strain Gauge, Bridge Sensitivity, Rosettes

Strain Gauge Alloys, Carriers and Adhesives-Performance of Strain Gauge System-Strain Gauge Selection-Bonding of a Strain Gauge-Soldering, Accounting for Transverse Sensitivity Effects-Correction Factors for Special Applications-Special Gauges

REFERENCES:

1. K. Ramesh, e-Book on Experimental Stress Analysis, IIT Madras, 2009. URL: http://apm.iitm.ac.in/smlab/kramesh/book_5.htm
2. K. Ramesh, Digital Photoelasticity â€“ Advanced Techniques and Applications, Springer, 2000.

3. W.N. Sharpe (Ed.), Springer Handbook of Experimental Solid Mechanics, Springer, 2008.
4. J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw-Hill, 1991.

COURSE OUTCOMES:

1. Understand stress strain analysis with its relation
2. Recognize materials structure and testing methods

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓	✓	✓	✓	✓						

PRPE18 Supply Chain Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To provide an insight on the fundamentals of supply chain strategy, logistics, sourcing and outsourcing supply chain networks, tools and techniques.

Evolution of supply chain-essentials of SCM-structure of supply chain, examples process views-decision phases, issues - aligning supply chain with business strategy –supply chain decision variables, performance measures-new challenges - reverse logistics.

Supply chain configuration design - factors involved - sourcing, models for strategic alliances – supplier selection, outsourcing and procurement process – facility location and capacity allocation - modeling approaches LP, MILP - network design in uncertain environment – evaluation using simulation models.

Demand forecasting-collaborative forecasting models-bullwhip effect-information sharing - aggregate planning in supply chain- strategies-multi echelon inventory planning-models- discounting- risk pooling- centralized versus decentralized systems.

Roles of transportation- tradeoffs in transportation design-modes of transportation and their design - vehicle routing and scheduling - models - packaging-pricing and revenue management.

Role of IT in supply chain -IT infrastructure-CRM-SRM-e-business-RFID-supply chain collaboration-Decision Support System (DSS) for supply chain- selection of DSS for supply chain.

REFERENCES:

1. Supply Chain Management: Strategy, Planning and Operations-Sunil Chopra, Peter Meindl, Prentice Hall India , 3rd ed., 2007.
2. Designing and Managing the Supply Chain: Concepts, Strategies, and Cases-David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Tata McGraw Hill, 3rd ed, 2007.
3. Modeling the supply chain, J. Shapiro, Thomson, 2nd ed., 2002

COURSE OUTCOMES:

1. Define structure of supply chain.
2. Design supply chain configuration.
3. Analyze the role of Transportation in SCM.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓	✓	✓	✓	✓						
CO3	✓	✓	✓	✓	✓	✓						

PRPE19 Plant Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To exemplify different types of plants and its functions.
- To analyse the principles used in plants maintenance.
- To understand the safety methods in plants.

Organization of the plant engineering function-Classification of maintenance work-Electric power supply system's-Electric generators and turbines-compressors, ventilation and air-conditioning Producer Gas Plants-operation and safety aspects in P.G. Compressor and Oxygen plants Material handling system-AS and RS (Automatic Storage and Retrieval System)-AGV and robotics- piping system design and components-Pollution control and plant safety

Noise and vibration control - safety in plant operations, fire and electrical protection and prevention security equipment

Lubrication and corrosion**-** Synthetic and solid lubricants -lubrication systems - causes and control deterioration - paints and protective coatings.

REFERENCES:

1. Rosaler, R.C. "Standard HandBook of Plant Engineering", 3rd Edition, McGraw Hill, 2002.
2. Lindley and Higgins, "Maintenance Engineers Hand Book", 7th Edition, McGraw HillProfessional, 2008.

COURSE OUTCOMES:

1. Understand the different type of plant and material handling system AS and RS (Automatic Storage and Retrieval System)-AGV and robotics.
2. Define the principles, functions and practices adapted in industry for the successful management of maintenance activities.
3. Know about safety in plant operation, fire and electrical protection and prevention security equipment.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓						
CO2	✓		✓		✓	✓						
CO3	✓				✓	✓						

PRPE20 Design and Analysis of Experiments

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To provide an introduction to fundamental concepts of statistical Process control.
- To enhance student understanding of the complexities of Statistical Analysis and control chart interpretation.

Introduction- Planning of experiments – Steps – Need - Terminology: Factors, levels, variables, experimental error, replication, Randomization, Blocking, Confounding.
Single Factor Experiments- ANOVA rationale - Sum of squares – Completely randomized design, Randomized block design, effect of coding, Comparison of treatment means – Newman Kuel's test, Duncan's Multiple Range test, Latin Square Design, Graeco-Latin Square Design, Balanced incomplete design.
Factorial Experiments-Main and interaction effects –Two and three Factor full factorial Designs, 2k deigns with Two and Three factors-Unreplicated design- Yate's Algorithm
Special Experimental Designs: Blocking in factorial design, Confounding of 2k design, nested design-Response Surface Methods.
Taguchi Techniques- Fundamentals of Taguchi methods, Quality Loss function, orthogonal designs, application to Process and Parameter design.

REFERENCES:

1. Montgomery, D.C. "Design and Analysis of Experiments", John Wiley and Sons, 5th Edition,2002.
2. Hicks,C.R. "Fundamental concepts in the Design of Experiments", Holt, Rinehort and Winston, 2000.
3. Bagchi, T.P. "Taguchi Methods explained", PHI, 2002.
4. Ross, P.J. "Taguchi Techniques for quality Engineering", Prentice Hall, 2000.

COURSE OUTCOMES:

1. Create steps, need and terminology for experiments
2. Know about factorial experiments and special experimental techniques
3. Apply Taguchi techniques for various design problems

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓						
CO2	✓	✓		✓	✓	✓						
CO3	✓	✓		✓	✓	✓						

PRPE21 Lean Manufacturing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the principles and concepts of lean manufacturing
- To gain hands on experience on lean tools and techniques
- To realize the industrial applications of lean manufacturing

Lean Manufacturing – Scope – Waste and Activity analysis – Examples – Elements of Lean Manufacturing, Mass vs Lean Manufacturing

Primary tools of Lean manufacturing – 5S, Total Productive Maintenance, OEE Calculation, Process mapping and Value Stream Mapping – Development and analysis of Current and Future state maps, Workcell, Application cases on lean tools

Secondary tools – Poka Yoke, Spider Chart, DFMA, Kanban, Autonomation, JIT, Pull system

Lean Manufacturing rules – Training & Implementation for lean manufacturing, Lean measurement, Project selection for lean systems.

Lean integration with other strategies: Lean Six Sigma, Lean and ERP, ISO 9001 with Lean, Optimized Production Technology, Lean in service domain.

REFERENCES:

1. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.
2. Hobbs, D.P. “Lean Manufacturing implementation”, Narosa Publisher, 2004.
3. Devadasan S.R, “Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities”, Prentice Hall India Learning,2012
4. Pascal Dennis, “ Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, Productivity Press, 2015
5. William M Feld, “Lean Manufacturing: Tools, Techniques, and How to Use Them (Resource Management)”, CRC Press,2000
6. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.
7. James Edge, “Lean: The Ultimate Guide to Lean Six Sigma, Lean Enterprise, and Lean Manufacturing + Lean Analytics - The Agile Way to Build a Superior Startup Using Data Science”, Createspace Independent Publishing, 2018

COURSE OUTCOMES:

1. Competence to recognize and eliminate waste
2. Understand and apply appropriate lean tools/techniques
3. Explore applications of lean concepts in various domains

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓	✓					
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

PRPE22 Material Handling and Storage

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand about material handling systems.
- To understand material storage methods.
- To understand automation in material transfer.

Introduction to material handling- Principle of material handling equipment-layout and aerial handling systems- Types of material handling systems.

Fixed Path Equipment- flexible-path equipment - Conveyers-automated guided vehicles (AGV) - Applications of AGV Production line equipments-pick and place robots-transfer devices-feeder lines, robotic devices

Conveyors-storage equipments-Automated ware houses- types of storage systems-small containers - unit load containers - rack and shelving

Automated storage and retrieval systems-methods of protecting materials for packages - auxiliary equipments -automated identifications systems

REFERENCES:

1. Groover, M.P. "Automation ,Production systems and computer integrated manufacturing" Part V , P HAllInc.New Delhi, 2007.
2. Apple, J.M. "Materials handling systems design", The Ronald Press Co.N.Y. 2001.

COURSE OUTCOMES:

1. Classify various material handling and storage systems.
2. Identify various fixed path equipment.
3. Summarize various packaging techniques.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓			✓		✓						
CO3	✓					✓						

PRPE23 Sustainable Manufacturing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study various tools/techniques of sustainable manufacturing.
- To perform Life Cycle Assessment and assess environmental impacts of manufacturing processes.
- To develop eco-friendly products/processes.

Sustainable Manufacturing - Concept of Triple bottom line, Environmental, Economic and Social Dimensions of Sustainability, Relation between lean and sustainable manufacturing.

Tools and Techniques – Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly, Design for recycling, Eco friendly product design methods.

Environmental Impact Assessment Methods –CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters.

Sustainability Assessment – Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

Sustainable characteristics of manufacturing processes - Energy efficiency analysis of manufacturing processes - Software packages for sustainability analysis and LCA - Scope of sustainable manufacturing research centres.

REFERENCES:

1. G. Atkinson, S. Dietz, E. Neumayer, “Handbook of Sustainable Manufacturing”. Edward Elgar Publishing Limited, 2007.
2. D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, UN New York, 2007.
3. Rainer Stark and Günther Seliger, “Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives (Sustainable Production, Life Cycle Engineering and Management)”, Springer, 2017
4. J. Paulo Davim, “Sustainable Manufacturing”, Wiley-ISTE, 2013
5. P. Lawn, Sustainable Development Indicators in Ecological Economics, Edward Elgar Publishing Limited.
6. S. Asefa, The Economics of Sustainable Development, W.E. Upjohn Institute for Employment Research, 2005.

COURSE OUTCOMES:

1. Recognize the need for sustainable manufacturing.
2. Competence on State-of-art tools and techniques of sustainable manufacturing.
3. Design Eco friendly processes/products.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓		✓					✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

PRPE24 **Industry 4.0**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To recognize need and trends of Industry 4.0.
- To understand concepts and technologies supporting Industry 4.0.
- To explore challenges and industrial applications of Industry 4.0.

Various Industrial Revolutions, Digitalization and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Digital twin - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation, Lean Production Systems.

Sensing & actuation, Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Predictive Analytics

Cyberphysical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Cyber Security, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis

Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0

Industry 4.0 laboratories, IIoT case studies, Application Domains, Business Issues, Opportunities and Challenges, Strategies for competing in an Industry 4.0 world

REFERENCES:

1. Gilchrist, A. (2016). Industry 4.0: the industrial internet of things. (1st ed.), New York, NY: Apress.
2. Schwab, K. (2017). The fourth industrial revolution. (1st ed.), UK: Portfolio Penguin.
3. Garbie, I. (2016). Sustainability in manufacturing enterprises: Concepts, analyses and assessments for industry 4.0. (1st ed.), Switzerland: Springer International Publishing.

COURSE OUTCOMES:

1. Understand trends of Industry 4.0.
2. Competence on systems and technologies of Industry 4.0.
3. Recognize industrial applications of Industry 4.0.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓									
CO2	✓	✓	✓	✓	✓	✓		✓	✓		✓	
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓

PRPE25 Integrated Materials Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand various concepts and functions of material management.
- To classify inventory management.
- To summarize Material handling and Logistic.

Importance of materials management – Scope – Functions of Materials Management – Need for Integrated Materials Management – Benefits.
Corporate Policy – Organisation and control – Materials planning and budgeting – Codification and standardisation – Forecasting – Purchasing Management – Objectives – Types of purchasing – Legal aspects – Value Engineering – Buyer-Seller relationship – Ethics.
Warehousing and Stores Management – Introduction – Store accounting and stock verification – ABC analysis – stores location and layout – Material handling – Inventory management.

REFERENCES:

1. Gopalakrisnan, P. “Purchasing and Materials Management”, McMillan Company, 2006
2. Gopalakrishnan, P. and Sundaresan, M. “Materials Management and Integrated Approach”, PHI Private Limited, 2014.
3. Datta, A.K. “Materials Management Procedures, Text and Cases”, PHI Private Limited, Second Edition, 2008.
4. Telsang, M.“Industrial Engineering and Production Management”, S.Chand and Company, 2006.
5. Prem Vrat, “Materials Management An Integrated Systems Approach”, Springer, 2014.
6. Chary, S.N.“Production and Operations Management”, Tata McGraw Hill, 2006.
7. Panneerselvam, R. “Production and Operations Management”, PHI Learning Private Limited, 2012.

COURSE OUTCOMES:

1. Understand various concepts and functions of material management.
2. Classify inventory management.
3. Summarize Material handling and Logistic.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓			✓		✓						
CO3	✓					✓						

PRPE26 Agile Manufacturing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the significance and scope of Agile Manufacturing.
- To recognize technologies and managerial enablers of Agile Manufacturing.
- To realize industrial applications of Agile Manufacturing.

Types of Production- Agile Production Paradigm- History of Agile Manufacturing- Agile Manufacturing Vs Mass Manufacturing, Agile Manufacturing Vs Mass Customization Agile Practices- Agile practice for product development - Manufacturing agile practices - Concept models of Agile Manufacturing- Infusing managerial principles for enabling agility.

Implementing technology to enhance agility- Information Technology applications for Agile Manufacturing, Strategic approach to agility – Agile Wheel.

Performance Measurement and Costing: Measurement of agility – methods – Scoring and Fuzzy approaches – Costing for Agile Manufacturing practices – Activity Based Costing.

Applications of Agile Manufacturing – Scope of Agile Manufacturing Research Centers.

REFRENCES:

1. Gunasekaran A, “Agile Manufacturing, 21st Strategy Competitiveness Strategy”, Elsevier Publications, 2001.
2. Montgomery J C and Levine L O, “The Transition to Agile Manufacturing – Staying Flexible for Competitive Advantage”, ASQC Quality Press, Wisconsin, 1995.
3. Carter Mathews, “Agile Manufacturing: Lean Processes that Improve Business Tranctions”, Brithe Publishing, 2017
4. M P Chowdiah, “Agile Manufacturing: Globalised Customerized”, I K International Publishing, 2011
5. Goldman S L, Nagal R N and Preiss K, “Agile Competitors and Virtual Organizations”, Van Nostrand Reinhold, 1995.
6. Brian H Maskell, “Software and the Agile Manufacturer, Computer Systems and World Class Manufacturing, Productivity Press, 1993

COURSE OUTCOMES:

1. Recognize the principles and concepts of agile manufacturing
2. Competence on applying models enabling agility
3. Explore industrial applications of agile manufacturing

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓						
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

PRPE27 Industrial Robotics

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the components of robot.
- To understand the drives and programs used to actuate the robot.
- To utilize robot technology in various applications.

Fundamentals of Robotics: Definition - robot classification - robot arm geometry - power sources, application areas - control techniques - path control - robot controller operation - open loop and closed loop systems.

End of arm tooling and sensors: characteristics - classification - special purpose tools - Typical designs, compliance in Wrists. End Effectors: types, mechanical and other types of griper - types of sensors and applications.

Robot Programming And Languages: Language classification - program commands, arm motion, task point diagram - on line/off line programming, sample programs, program analysis - AI and experts systems.

Robot Applications: Robot applications in manufacturing - material transfer and machine loading / unloading - Processing operations like welding and painting - Assembly operations - Inspection Automation. Robot cell layouts - multiple robots and machine interference.

Recent developments: Recent developments in advanced Robotics –Modular concept - Special applications of robotics - micro robotics, Bio robotics - technologies and applications.

REFERENCES:

1. Keramas,J.G. “ Robot Technology Fundamentals”, Delmer Publisher, 2002
2. Jain, K.C, and Aggarwal, L.N., “Robotics Principles and Practice”, Khanna Publishers, 2001
3. Groover, M.P., "Industrial Robotics", McGraw Hill International Editions, 2008.
4. Deb, S.R., “Robotics Technology and Flexible automation”, Tata McGraw Hill Pub., New Delhi, 1994.

COURSE OUTCOMES:

1. Explain the basic concepts, parts of robots and types of robots.
2. Identify the various drive systems for robot, sensors and their applications in robots, programming of robots.
3. Discuss about the various applications of robots, justification, implementation and safety of robot.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓			✓	✓	✓						
CO3	✓					✓						

PRPE28 Unconventional Machining Processes

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand several non-traditional machining process in micro and precision manufacturing field.
- To select suitable machining process for materials considering their merits and demerits.

Introduction - Classification - process economy - Mechanical machining – Types - Ultrasonic machining (USM) - Abrasive Jet Machining (AJM) - Abrasive Flow Machining (AFM) - Water Jet Machining (WJM) - Operating principle – Process parameters - Applications - Limitations.

Electro chemical machining - Chemical material removal - Types – Electro chemical machining (ECM) - Electro chemical drilling (ECD) - Electro chemical grinding (ECG) - Electro chemical honing (ECH) - Shaped tube electrolytic machining - Operating principle - Process parameters - Applications - Limitations.

Thermo electrical machining - Types – Electrical discharge machining (EDM) - Electrical discharge wire cutting (EDWC) - Electron beam machining (EBM) – Ion Beam Machining (IBM)-Plasma Arc Machining (PAM) - Operating principle - Process parameters - Applications – Limitations

Laser materials processing - Laser types - Processes - Laser beam machining (LBM) – Laser cutting (LC) – Laser drilling (LD) - Laser marking and engraving (LM) - Laser micromachining (LMM) - Laser engineered net shaping (LENS) - Applications - Limitations.

REFERENCES:

1. Abdel, H. and El-Hofy, G. “Advanced Machining Processes”, McGraw-Hill, USA, 2005.
2. Wellar, E.J. "Non-Traditional Machining Processes", Society of ManufacturingEngineers Publications, 2nd Edition, Michigan, 1984.
3. Steen, W.M. and Watkins, K. “Laser Materials Processing”, Springer London Ltd, 2003.
4. Groover, M.P. “Fundamentals of modern manufacturing processes - Materials, Processes and Systems”, 3rd Edition, John Wiley and Sons Inc., 2007.

COURSE OUTCOMES:

1. Understand the contribution of non-traditional machining process in micro and precision manufacturing field.
2. Select suitable machining process for suitable materials
3. Summarize the merits and demerits of the non-traditional manufacturing process.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓				✓	✓						
CO3	✓											

PRPE29 **Precision Engineering**
(Theory and Lab)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To provide and enhance technical knowledge in precision engineering, its components and applications.

Precision machining – Concepts and significance – Classification - Top down – Bottom up approaches– Precision and micromachining - Machining of micro-sized components - Ultra precision machining grinding

Lithography – Photolithography - Electron beam lithography – Ion Beam lithography - Deep UV lithography–MEMS – Principle – Elements – Characteristics – Applications- Design and fabrication approaches.

Micro-manufacturing- Limits of capability of conventional mechanical manufacturing- Micro- machining-concepts-Types–Tools–Electrical Discharge Micro-Machining–Wire cut EDMM– Electro Chemical Micro-Machining-Abrasive Jet Micromachining - Laser based micromachining

Nano surface generation-Concepts and applications-Types- Ductile mode of machining- Diamond turning of parts to nanometer accuracy – ELID grinding – Chemo Mechanical Polishing- Magnetorhelogical finishing.

Precision metrology –In-process measurement of position of processing point - Post process and online measurement of dimensional features -Mechanical measuring systems - Optical measuring systems - Electron beam measuring systems – Scanning Tunneling – Atomic Force Microscope.

LAB EXERCISES

1. Exercise on Micro-turning operation on DT-110 Multi-process micro-machining center.
2. Exercise on Micro-milling operation on DT-110 Multi-process micro-machining center.
3. Exercise on Micro-drilling operation on DT-110 Multi-process micro-machining center.

REFERENCES:

1. SeropeKalpakjain, “Manufacturing Engg. and Technology”, Pearson Education, 2005.
2. V.K.Jain, “Introduction to Micromachining”, Narosa Publishing House, 2010.
3. M.J. Madou, “Fundamentals of Micro Fabrication”, CRC Press, 2002.

4. Mark J. Jackson, “Micro Fabrication and Nano machining”, Taylor and Francis, 2006.
5. Yi Qin, “Micro-Manufacturing Engineering and Technology”, Elsevier Publication, 2010.

COURSE OUTCOMES:

1. Understand the concept of precision engineering, its principles and importance as applicable to instruments and machines.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓			✓						

PRPE30 Manufacturing of Composite Materials

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand and classify the properties of composite materials.
- To understand and study the Polymer matrix composite processing methods.
- To design and study the metal matrix composite and Ceramic matrix composites processing methods.

FRP composites – Fiber types, fiber forms and properties, matrices type and properties, lamina, laminate, orthotrophy, anisotrophy, composites
Macro and micro-mechanical analysis and properties, Failure theories – Tsai – Hill, Tsai-Wu
Primary and secondary manufacturing of composites – Lay-up, Autoclave Molding filament Winding, Pultrusion, Compression Molding, RTM, RIM, SRIM, machining, drilling and routing
Metal matrix composites – Manufacturing route Design, Structural and testing, application
Ceramic matrix composites – Manufacturing routes and application

REFERENCES:

1. Mein Schwartz., “Composite Materials Handbook”, McGraw Hill, 1992
2. AutarK.Kaw, “Mechanics of Composite Materials”, CRC Press, 2005.
3. “ASM Hand book on Composites”, Volume 21, 2001

COURSE OUTCOMES:

1. Define and classify the fundamentals of composite material.
2. Identify processing methods of the polymer matrix composite material.
3. Select and identify processing methods for metal matrix composite and ceramic matrix composites.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓			✓						
CO3	✓		✓			✓						

PRPE31 Machine Tool Technology

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand different types of machine tools.
- To analyse the source of vibration in machine structure.
- To apply automation in machine control.

Classification of machine tools - features construction and operation of basic machine tools - different types and mechanics of transmission of machine tool motion - kinematic structure of machine tools

Mechanical drives for rotational movement - stepped and step less O/P -mechanical drives for reciprocation

Strength and rigidity of machine tool structures - design of lathe beds - design of drill columns - analysis of spindle bearings hydrodynamic bearings - stack slip motion - hydrostatic bearings-

Vibration of machine - sources of vibration

Semi automation - automatic machines with mechanic controls.

REFERENCES:

1. Sen, G.C. and Bhattacharya, A., "Principles of machine tools", New Central Book Agency, Calcutta, 2006.
2. Mehta, N.K., "Machine tool design", Tata McGraw Hill Co., N.Delhi , 2008.

COURSE OUTCOMES:

1. Classify different types of machine tools
2. Analyse vibration of machine structures
3. Design lathe beds, drill columns

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓				✓						
CO3	✓					✓						

PRPE32 Non Destructive Testing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study various Non-Destructive Testing methods and evaluation and their industrial applications.

OVERVIEW OF NDT: NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

SURFACE NDE METHODS: Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing-Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

THERMOGRAPHY AND EDDY CURRENT TESTING: Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION: Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications

RADIOGRAPHY: Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

REFERENCES:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010
1. ASM Metals Handbook,”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005
3. Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing,

COURSE OUTCOMES:

1. Test defects in components by Non Destructive Testing methods.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						

PRPE33 Surface Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To develop fundamental understanding and the role of materials to allow surface selection for mechanical contact surfaces
- To get familiarized with classical surface treatments, as well as with the modern ones, paying special attention to industrial applications.

Introduction- Significance of surface engineering- Solid surface- Surface energy- Superficial layer- Physico-chemical parameters- Properties of the superficial layer- Surface coating- Classification. Physical vapor deposition (PVD): Ion plating- Sputter deposition- Reactive deposition- Magnetron sputtering- Chemical vapor deposition (CVD)- Ion implantation- Electron beam technology- Applications.

Thermal Spraying Techniques- Flame Spraying, Atmospheric Plasma Spraying (APS), Vacuum Plasma Spraying (VPS), Detonation-Gun Spraying (D-GUN), High-Velocity Oxy-Fuel (HVOF) Spraying-Applications.

Laser surface engineering- Laser transformation hardening - Laser remelting- Laser alloying- Laser cladding- Laser ablation- Pulsed laser deposition- Laser doping - Laser crystallization- Laser surface texturing- Laser shock peening.

Methods of characterization-Microstructure- Mechanical: Adhesion-Hardness-Residual stress- Friction-Wear- Physical: Porosity-Density- Electrical: Conductivity-Magnetic- Chemical.

REFERENCES:

1. Tadeusz Burakowski, TadeuszWierzchon, “Surface Engineering of Metals-Principles, equipment and technologies”, CRC Press, 1999.
2. Lech Pawlowski, "The Science and Engineering of Thermal Spray Coatings", 2nd Edition, John Wiley & Sons, 2008.
3. William M. Steen, JyotirmoyMazumder, “Laser Material Processing”, 4th Edition, Springer Verlag, 2010.

COURSE OUTCOMES:

1. Understand the importance, need of surface engineering and review past, present and future status of surface engineering.
2. Relate the micro mechanism failure to optimize surface engineered microstructures.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓	✓			✓	✓	✓		✓
CO2		✓	✓			✓	✓		✓		✓	

PRPE34 Processing of Polymeric Composites

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the methods of preparation, properties and applications of thermoplastic materials.
- To identify engineering and high performance plastics for specific application.

Methods of manufacturing - Properties and applications of polyethylene - LDPE - LLDPE- HDPE, HMWHDPE- UHMWHDPE - Cross linked polyethylene- Chlorinated polyethylene - Polypropylene - Homopolymers - Copolymers.

Methods of manufacturing - Properties and applications of poly(vinyl chloride)- Poly (vinylidene chloride)- Poly(vinyl alcohol) - Poly(vinyl acetate)- Chlorinated poly(vinyl chloride)- Plastisols, Poly vinylpyrrolidiene, Polystyrene, HIPS, EPS, SAN, EVA, EPDM, ABS.

Methods of manufacturing - properties and applications of Acrylates - Poly (methyl methacrylate) - Polyacrylonitrile. Aliphatic polyamides –Aromatic polyamides- Polyethylene terephthalate - Polybutylene terephthalate - Polyacetals and copolymers -Polycarbonates- Thermoplastic polyurethane (TPU)

Methods of manufacturing- Properties and applications of Fluoro polymers - Polytetrafluoroethylene, Polychlorofluoroethylene, Thermoplastic polyurethanes, Biodegradable polymers - poly ξ–caprolactone and copolymers - polylactic acid- Bacterial polyhydroxy alkonates.

Preparation, properties and applications of High performance Thermoplastic materials PPS, PO, Polysulphone, Polyether Sulphone, PEEK, Polyimide. Biopolymer-cotton wool, collagen, hyaluroran.

REFERENCES:

1. J.A.Brydson, “Plastics Materials”, Butterworth- Heinemann - Oxford, 6th Ed., 1995.
2. Feldman.D and Barbalata.A, “Synthetic Polymers”, Chapman Hall, 1996.
3. OlagokeOlabisi, “Hand Book of Thermoplastics”, Marcel Decker, inc., 1997
4. K.J. Saunders, “Organic Polymer chemistry”, Chapman & Hall, NY, 1988.
5. Irvin.I. Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience, NY, 1990.
6. Charles Gebelein, Biotechnological Polymers: Medical, pharmaceutical and industrial applications, CRC press,1993

COURSE OUTCOMES:

1. Familiarize in manufacturing process of polymer.
2. Acquire skills in selecting polymeric materials for specific applications.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						✓
CO2	✓					✓						✓

PRPE35 Introduction to Friction Composites

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To demonstrate knowledge of brake systems principles and operations.
- To identify various raw materials and different types of friction composites.
- To study industrial standard practices in testing the friction composites and brake systems.

Introduction: Laws of friction- types of friction- wear- types of wear- mechanism involved in wear.

Brake system and Assembly: Basic requirements and functions of braking system, Types of brakes, hydraulic brake system, compressed air brake system, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, ABS, EBSD, anti-skid braking system, brake efficiency and testing, weight transfer, braking ratio.

Types of Friction Materials & Applications: Friction Materials -Definition and Nature Overview of types- Organic Friction Materials- Ceramic Friction Materials- Sintered Friction Materials- Applications of friction materials with industrial case studies.

Ingredients & Manufacturing: Raw Materials- Classification of raw materials: Fillers, Binders, Friction Modifiers, Structural Reinforcement- Properties of raw materials - Manufacturing Process– Industrial case studies.

Characterizations: Types of Characterizations: Physical, Chemical, Mechanical, Thermal, Tribological and Microstructural characterization as per industrial standards– case studies.

REFERENCES:

1. Automotive Brake Systems, Robert Bosh GmbH, 1995, First edition, USA.
2. ASM Handbook, Friction, Lubrication, and Wear Technology, Volume18, 1992, USA.
3. Peter J.Blau, Friction Science and Technology- From Concepts to Applications, Second Edition, 2009, CRC Press, USA.
4. Rudolf Limpert, Brake design and safety, II edition, SAE International, Warrendale,1999.

COURSE OUTCOMES:

1. Demonstrate knowledge of brake systems principles and operations.
2. Identify various raw materials and different types of friction composites.
3. Study industrial standard practices in testing the friction composites and brake systems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓					✓			✓
CO2	✓	✓					✓		✓			✓
CO3	✓	✓				✓			✓			✓

PRPE36 Work Design and Facilities Planning

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand method study and work management techniques

Methods study - motion and time study, and productivity - micromotion and macromotion study - Ergonomics.

Work measurement - techniques of work measurement - time study - production study.

Facility layout - steps in facility location study - layout types and analysis.

Layout design process - systematic layout planning - analysis - designing the layout - Assignment model.

Computerized layout planning - CRAFT, ALDEP and CORELAP

REFERENCES:

1. Barnes, Motion and time study, John Wiley, New York, 1990.
2. ILO, Introduction to work study, ILO,Geneva,1974.

COURSE OUTCOMES:

1. Perform ergonomic analysis
2. Perform computerized layout planning
3. Perform work measurements

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓		✓				✓
CO2	✓	✓	✓	✓	✓	✓	✓					✓
CO3	✓	✓	✓	✓	✓	✓		✓				✓

PRPE37 Reliability and Maintenance Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To identify and analyze failures of components and subcomponents of mechanical and electronic items.
- To distinguish different concepts in maintenance and explore in order to increase service life of the products/machines

Definition of reliability – reliability Vs quality-reliability function-MTTF – hazard rate function- bathtub curve – derivation of the reliability function-constant failure rate model – time dependent failure models. Weibull distribution – normal distribution – the lognormal distribution. Serial configuration – parallel configuration – combined series parallel systems – system structure function, minimal cuts and minimal paths – Markov analysis – load sharing systems, standby system, degraded systems, three state devices – covariate models, static models, dynamic models, physics of failure models.

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle – Principles and methods of lubrication – TPM – Condition monitoring

REFERENCES:

1. David J Smith, Butterworth-Heinemann,Reliability Maintainability and Risk; Practical methods for engineers, New Delhi, 2001
2. B.S. Dhillon, Maintainability, Maintenance and Reliability for Engineers,CRC Press, 2006
3. Roger L. Brauer, Safety and Health for Engineers, John Wiley Sons, 2006
4. Hoang Pha, Handbook of Reliability engineering, Springer Publication, 2003.
5. B.S. Dhillon, Engineering maintenance; a modern approach,CRCPress, 2002
6. Butterworth-Heinemann,R. Keith Mobley, Maintenance Fundamentals, II edition, 2004

COURSE OUTCOMES:

1. Identify and analyze the failures of the components and subcomponents of mechanical and electronic items.

2. Distinguish different concepts in maintenance and explore in order to increase the service life of the products/machines.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓					✓
CO2	✓	✓	✓	✓	✓	✓	✓					✓

PRPE38 Vibration and Noise Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the sources of vibration and noise in automobiles and make design modifications to reduce the vibration and noise and improve the life of the components.

BASICS OF VIBRATION: Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non-linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

BASICS OF NOISE: Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

AUTOMOTIVE NOISE SOURCES: Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tire noise, brake noise.

CONTROL TECHNIQUES: Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

SOURCE OF NOISE AND CONTROL: Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers

REFERENCES:

1. SingiresuS.Rao, “Mechanical Vibrations”, 5th Edition, Pearson Education, 2010.
2. Benson H. Tongue, “Principles of Vibrations”, 2nd Edition, Oxford University, 2007
3. David Bies and Colin Hansen, “Engineering Noise Control – Theory and Practice”,4th Edition, E and FN Spon, Taylore&Francise e-Library, 2009
4. William T. Thomson, Marie Dillon Dahleh, ChandramouliPadmanabhan, “Theory of Vibration with Application”, 5th Edition Pearson Education, 2011
5. Grover. G.T., “Mechanical Vibrations”, Nem Chand and Bros., 1996

COURSE OUTCOMES:

1. Understand causes, source and types of vibrations in machineries
2. Gain knowledge in sources and measurement standard of noise
3. Design and develop vibrations and noise control systems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓						✓
CO2	✓	✓	✓	✓	✓	✓						✓
CO3	✓	✓	✓	✓	✓	✓						✓

PRPE39 **Data Analytics**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To realize the importance of data analytics.
- To gain competence on data analytics approaches
- To explore real life applications of data analysis and handling big data.

Introduction to Multivariate Statistics-Degree of Relationship among Variables-Review of Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

Regression Modelling - Multiple Regression- Linear and Nonlinear techniques-Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance - Multivariate Analysis of Variance and Covariance. Logistic regression: Regression with binary dependent variable -Simple Discriminant Analysis-Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis.

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis.

Bayesian Modelling, Inference and Bayesian Networks, Support Vector and Kernel methods, Neural networks -Supervised and Unsupervised learning and Fuzzy logic approaches.

Latent Variable Models an Introduction to Factor, Path, and Structural Equation Modelling- Time series data analysis (ARIMA model) – Decision tree analysis-Introduction to Big Data Management, Approaches for handling big data- Overview on Machine Learning- Brief review of R and Python for data analysis.

REFERENCES:

1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", (7th edition). Pearson India.2015
2. Tabachnick, B. G., &Fidell, L. S., "Using multivariate statistics", (5th edition). Pearson Prentice Hall,2001
3. Gujarati, D. N. , "Basic econometrics", Tata McGraw-Hill Education,2012
4. Malhotra, N. K., " Marketing research: An applied orientation", 5/e. Pearson EducationIndia, 2008
5. Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. " Applied multiple regression/correlation analysis for the behavioral sciences", Routledge.,2013
6. Han, J., Kamber, M., & Pei, J. "Data mining: concepts and techniques: concepts and techniques", Elsevier,2011
7. Anil Mahershwari , Data Analytics, McGraw Hill Education; First edition (1 July 2017)

COURSE OUTCOMES:

- Recognize the concepts of data analytics
- Understand various approaches of data analytics
- Explore the scope of data analytics in industrial applications

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	-
CO2	✓	✓	✓	✓	✓	✓	✓	-	✓	-	✓	-
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓

PRPE40 Numerical Methods for Engineers 2 - 1 - 0 – 3

Course Objectives

- To apply various numerical computational techniques to solve various engineering problems
- Develop and implement numerically stable and accurate procedure for all the basic tasks of engineering

Introduction - computer architecture - number representations – recursion, error propagation - error estimation - condition numbers

Linear Systems - Gaussian elimination – pivoting - LU factorization - tri-diagonal systems special matrices - iterative methods - convergence of iterative schemes

Roots of non-linear equations – bisection – Newton-Raphson iteration - interpolation of functions by polynomials -Lagrange Interpolation - triangular family -numerical differentiation and integration

Ordinary differential equations -initial value problems - Euler and Runge-Kutta Methods - boundary Value problems, finite difference methods, minimization Problems - least square approximation – optimization

References

1.Numerical Methods Using MATLAB, John H. Mathews, Kurtis K. Fink, Pearson Publishers, 2004.
2. Numerical methods for engineers by Steven C. Chapra and Raymond P. Canale. McGraw-Hill. 2015.
2. Numerical methods for engineers and scientists by Joe D. Hoffman. Marcel Dekker, Inc. 2001.
3. Numerical methods with programs in C by T. Veerarajan and T. Ramachandran. Tata McGraw-Hill. 2006.

Course Outcomes

- Develop stable algorithms for solving linear systems of equations.
- Develop efficient and stable algorithms for solving non-linear equations.
- Implement numerically stable recursion algorithms for evaluating mathematical functions.
- Understand the use of interpolation for numerical differentiation and integration.
- Develop stable solution algorithms for ordinary differential equations.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓					✓
CO2	✓	✓	✓	✓	✓	✓	✓					✓

PRPE41 Product and Service Life Cycle Management 3 - 0 - 0 – 3

Course Objectives

- Define the fundamentals of PLCM system.
- Choose a suitable strategy for the requirement.
- Understand the importance of concurrent engineering.
- Discuss the various components of PDM with related concepts.
- Learn the projects and roles.

Product life cycle management – Need for PLM, Components of PLM, Product Data and Product workflow, Drivers for Change, The PLM Strategy, Developing a PLM Strategy, A Five-step Process.

Cost of design changes, Concurrent Engineering, schemes for concurrent engineering like Design for manufacturing and assembly, robust design, failure mode and effect-analysis, Computer aided DFM, Design rules.

Basic functionality of PDM: Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM

Document Management Systems: Document management and PDM, Document life cycle, Content Management.

Workflow Management in PDM: Structure Management, Engineering Change Management, Release Management, Version Management, Configuration Management

Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures

Service life cycle management: Workforce administration, Components planning and forecasting, Enterprise asset management, Reverse logistics, knowledge administration, Contract management, Returns and repair management

References

1. Product Lifecycle Management Paradigm for century Product Realization **-** John Stark, Springer- Verlag, 21st, London, 3rd printing -2006, ISBN: 1-85233-810-5.
2. Crnkovic, Ivica; Asklund, Ulf; & Dahlqvist, Annita Persson. *Implementing and Integrating Product Data Management and Software Configuration Management*, Artech House Publishers, 2003. ISBN 1580534988
3. Burden, Rodger *PDM: Product Data Management*, Resource Pub, 2003. ISBN 0970035225
4. Grieves, Michael. *Product Lifecycle Management*, McGraw-Hill, 2006. ISBN 0071452303

Course Outcomes

1. Explain product life cycle management concepts.
2. Analyse schemes of concurrent engineering.
3. Appraise product data management concepts and adapt PDM system architecture for a case study
4. Applications of service life cycle management

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓	✓					✓
CO2	✓	✓	✓	✓	✓	✓	✓					✓

CO3	✓	✓	✓		✓		✓				✓	✓
CO4	✓	✓	✓	✓	✓	✓						✓

OPEN ELECTIVE (OE)

PROE11 Project Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To enable the students to understand the methods for project identification and appraisal.
2. To plan and schedule a project with resource and environmental constraints.
3. To develop quantitative methods for project selection, risk assessment, monitoring and control.

Introduction - Project Management: An Overview – Types, Characteristics of Projects – Project life cycle. Identification of investment opportunities - Screening and Selection,

Project Appraisal, Market and demand analysis- market survey-demand forecasting methods-Technical analysis – manufacturing process, materials-product mix, plant location-project charts and layouts.

Financial analysis – cash flows for project appraisal- Investment evaluation using capital budgeting techniques - net present value, profitability index internal rate of return, payback period, accounting rate of return

Mathematical Techniques for project evaluation – Linear programming, goal programming, Network technique for Project Management – CPM, PERT, Multiple projects and constraints, scheduling. Performance metrics for project evaluation.

Organization systems for project implementation- Work Breakdown-coordination and control- Project Management Soft wares, Role of AI in project management

REFERENCES:

1. Prasanna Chandra, “Projects – Planning, Analysis, Financing, Implementation and Review”, Tata McGraw Hill,8th Ed, 2017
2. S.Choudry “Project Management”, ”, Tata McGraw Hill,5th Ed, 1995
3. Mike Field and Laurie Keller, “Project Management”, Thompson Business press, 2002
4. http://nptel.ac.in/courses/110104073/

COURSE OUTCOMES:

1. Understand the process and approaches for executing projects
2. Develop and analyze quantitative models for project selection and scheduling

3. Apply engineering and management principles to manage real time projects considering constraints.
4. Apply tools for managing complex projects
5. Analyse the outcome and offer suggestions for improvement

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓		✓					
CO2	✓	✓	✓				✓					
CO3	✓	✓	✓				✓					
CO4	✓	✓	✓		✓		✓					
CO5	✓	✓	✓	✓			✓			✓	✓	

PROE12 Value Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the concept and approaches of value analysis and engineering
2. To justify the value of money and value of product
3. To Implement Value Engineering in any type of organization

An Overview Of Value Engineering-Concepts and approaches of value analysis and engineering -importance of value, Function - identity, clarify – analysis.

Evaluation of VE-Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value.

Results accelerators, Basic steps in using the systems.

Understanding the decision environment, Effect of value analysis on other work in the business- Life Cycle Cost (LCC), Case studies.

VE Level Of Effort-VE Team, coordinator, designer, different services, definitions, construction management contracts, value engineering case studies, Effective organization for value work, function analysis system techniques- FAST diagram, Case studies.

REFERENCES:

1. Parker, D.E., “Value Engineering Theory”, Sundaram publishers, 1990.
2. Khanna, O.P., “Industrial Engineering and Management”, DhanpatRai and Sons, 1999.

COURSE OUTCOMES:

1. Understand the concept and approaches of value analysis and engineering
2. Justify the value of money and value of product
3. Implementation of Value Engineering in any type of organization

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓		✓						
CO2	✓	✓		✓		✓						
CO3	✓	✓		✓		✓						✓

PROE13 Artificial Intelligence and Expert systems

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study the concepts of Artificial Intelligence
- To understand the methods of solving problems using Artificial Intelligence
- To learn about the components of decision support system and expert systems.

Aspects of intelligence and AI - heuristic search - logic programming and reasoning - automatic programming-scope of AI-in manufacturing - components of intelligent manufacturing-

Requirements of AI languages - Languages Lisp and Prolog - simple programs

Knowledge engineering- protocol analysis - fuzzy logic - Semantic networks, learning systems - inference engine

Vision programs - factory vision systems - machine learning

Features of Experts systems - applications in manufacturing planning and control.

REFERENCES:

1. Simons, G.L., "Introducing Artificial Intelligence", NCC Publications, 1984
2. Maus, R and Keyes J Handbook of Expert Systems in manufacturing McGraw Hill, 1991
3. Ernest R Tello, "Mastering AI tools and techniques"

COURSE OUTCOMES:

1. Describe the basic concepts, Operations and Principles of Artificial Intelligence
2. Recognize the basic concepts, Operations and Principles of Fuzzy Logic
3. Employ the concept of AI & fuzzy logic in Manufacturing Environments

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓			✓	✓							
CO3	✓			✓	✓	✓						✓

PROE14 Processing and Manufacturing of Semiconductors

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand semiconductor and its types.
2. To understand and apply various processing techniques to fabricate semiconductors.

Introduction to semiconductors – Energy band theory – Classification – Intrinsic and extrinsic – P-type and N-type – P-N junction diode – semiconductor device design – photo-voltaic cells, bipolar and MOSFET transistor – applications

Basic requirements for semiconductor manufacturing - clean room – yield model – Wafer IC manufacturing – feature micro fabrication technologies – PSM – IC industry – New Materials – Bonding and layer transfer – devices – micro fabrication industries

Processing sequence – Oxidation – Growth kinetics, thin oxide growth, oxide quality – photolithography – Exposure tools, pattern transfer, deep UV sub-micron, E-beam lithography, X-Ray lithography – Etching – Wet chemical and dry etching

Doping – diffusion, Ion implantation – Physical and chemical vapour deposition – Planarization – chemical mechanical planarization – chemical-mechanical polish (CMP) – maintenance and troubleshooting

Modern semiconductor manufacturing – Process integration – Bipolar technology, CMOS technology – CMOS fabrication sequence – BiCMOS technology – Packaging – Die separation, Package types, attachment methods.

REFERENCES:

1. Yoshio Nishi, Robert Doering, “Handbook of Semiconductor Manufacturing Technology”, Second Edition, CPC press, 2008
2. Gary S. May, Costas J. Spanos, “Fundamentals of Semiconductor Manufacturing and Process Control”, Wiley- interscience, 2006
3. Hwaiyu Geng, “Semiconductor Manufacturing Handbook”, McGraw Hill Professional, 2005.

COURSE OUTCOMES:

1. Understand semiconductor and its types.
2. Understand and apply various processing techniques to fabricate semiconductors.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓					✓						

PROE15 Automobile component manufacturing processes

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn the basic processes available to make an automobile part/product.
- To select the best manufacturing process based on quality/time/cost/ mechanical properties.

Introduction: Classification and comparison of manufacturing processes. Criteria for selection of a process.

Casting: Casting of engine block - conventional and expendable pattern, Casting for cylinder heads, connecting rod and gudgeon pins, Casting of piston, upset forging of valves, piston ring manufacturing & Engine bearing manufacturing, Manufacturing of friction plates, Manufacture of composite friction lining, Casting of gear box casing, precision forging of gears, Continuous casting of propeller shaft, Forging of rear axles, casting of rear axle casing, wheels, brake drum.

Metal Forming: Basic concepts and classification of forming processes. Thermoforming, hydro forming & press forming, welding of body panels, Rolling, Extrusion, Wire drawing, Spinning. Powder metallurgy, steps involved, applications.

Advanced Manufacturing Processes: Use of EDM, ECM, ECG, USM, PAM, LBM for manufacturing of automobile components. Super Finishing Processes: Introduction to Grinding, Lapping, Honing, Buffing, Barrel Tumbling, Burnishing, Powder coating, Polishing.

Recent advances Application of sensors and actuators – Emission control system – catalytic converter – Hydro forming of exhaust manifold and lamp housing – stretch forming of Auto body panels – MMC liners – thermal barrier coating of Engine head and valves – Selection of materials for Auto components.

REFERENCES:

1. Hajra Choudhury, Elements of Workshop Technology, Vol-I and Vol-II Asia Publishing House, 1996.
2. R.K.Jain and S.C.Gupta, Production Technology, Hanna Publishers, 1997.
3. H.M.T. Production Technology-Hand Book, Tata McGraw Hill, 1990
4. Philip F Ostwald and Jairo Munuz, "Manufacturing Processes and Systems", John Wiley & Sons, New York, 1998.
5. Kalpakjian, "Manufacturing Engineering and Technology", Pearson Education, 2005.

COURSE OUTCOMES: .

1. Identify and select the methods of forging – for gudgeon pin, Crankshaft, connecting rod, camshaft, rocker arm, gears, shaft & axles, material suitability for above components, casting equipment, forging defects.
2. Select the non-conventional machining like EDM, ECM, ECG, USM, PAM, LBM for manufacturing automobile components.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓			✓						
CO2	✓		✓			✓						✓

PROE16 Laser Materials processing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the principles of laser and the operations of different types of lasers.
- To describe laser machining and joining process.

Fundamentals of laser - properties - spectrum and wavelength - types of laser - laser components - interaction of laser radiation with materials.

Laser surface treatment - laser transformation hardening - advantages over conventional processes - laser surface melting - laser alloying - laser cladding.

Introduction to laser welding - process arrangement - process mechanisms - operating characteristics - process variations - applications.

Introduction - methods of cutting - theoretical models of cutting - practical performance -applications - process variations - drilling - applications.

Laser marking-engraving-methods and processing-applications-laser cleaning-laser shock processing-laser peening-laser engineered net shaping

REFERENCES:

1. William M. Steen, “Laser Material Processing”, Springer Verlag, 2003.
2. K.Thyagarajan, Ajoy K.Ghatak, “Lasers, Theory and Applications”, Plenum Press, 1981.
3. J.F. Reddy, “Industrial Applications of Lasers”, Academic Press, New York, 1978.
4. Michael Bass, “Laser Materials Processing”, Elsevier Science, 1983.

COURSE OUTCOMES:

- Select the best suitable laser for processing of different materials.
- Use laser based equipment for surface coating, machining and welding.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓	✓		✓			✓	
CO2		✓	✓				✓		✓	✓		✓

PROE17 Digital Manufacturing for Industry 4.0

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To use engineering application software CAD/CAM/CAE skillfully to accomplish a digital manufacturing/validation of mechanical parts.
- To use engineering application software skillfully to design an optimum factory layout.
- To understand the components that constitute Industry 4.0.
- To establish a comprehensive understanding on modern manufacturing systems.

Unit 1: Basics of Design and Manufacturing

Digital Technologies in manufacturing - Basic terminologies: CAD, CAE, CAPP, CAM - Digital twin - Digital thread - NX for Design - NX CAM: NC programming - post processing - machine simulation - NX CAE: Nastran - Basics - Finite element analysis - meshing - solving - integration - case examples.

Unit 2: Process Simulation and Plant Design

Digital twins of production facilities - virtual commissioning of automation systems - human centered design and planning - assembly simulation for virtual process verification - robotics programming - optimization of production logistics and material flow - configuration of digital factory layout - case studies involving Tecnomatix.

Unit 3: Virtual testing and optimization

Innovation through design exploration - Simulation of actuators and controls - Acoustics - Durability - Model based system - Rotating machinery - Structural dynamics - Transfer path analysis - SCADAS - Sound and vibration analysis - case studies involving simcenter.

Unit 4: Industrial Internet of Things

Basics of Internet of Things - outline of IoT architecture - networking and communication - technology roadmap - challenges - future and potential of IoT - application in manufacturing industry - case studies.

Unit 5: Industry 4.0

Industry 4.0 - Introduction to Industrial revolution - Components of Industry 4.0: Digital manufacturing, augmented reality, Industrial Internet of Things, Big data analytics, cyber physical systems, cloud computing, artificial intelligence, cognitive computing, machine learning, cyber security.

REFERENCES:

1. Zhou, Zude, Xie, Sheng, Chen, Dejun, Fundamentals of Digital Manufacturing Science. Springer Series in Advanced Manufacturing, 1st Edition, 2012.
2. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cybermanufacturing Systems, Springer, 1st edition, 2017.
3. Web Reference: https://www.plm.automation.siemens.com/global/en/

COURSE OUTCOMES:

1. Understand CAD/CAM/CAE working process and technology development trend.
2. Understand how digital manufacturing improves productivity.
3. Make smarter decisions that enhance efficiencies, launch products faster and increase competitiveness.
4. Apply IoT for manufacturing solutions.
5. Implement Industry 4.0 concepts on any existing systems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓							✓		✓		
CO2	✓	✓	✓		✓	✓	✓	✓		✓		✓
CO3	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓							✓		✓		

PROE18 Micro and Nano Manufacturing

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the principles of various micro and nano manufacturing processes, basic machine tools and recent developments in micro and nano manufacturing.

Introduction to meso, micro and nano manufacturing- miniaturization and applications – micro-manufacturing – classification – micro-machining: concepts and significance-theory of micro-machining – chip formation -size effect in micro-machining.

LIGA, micro-stereolithography – micro-turning, micro-drilling, micro-milling, diamond turn machining - electric discharge micro-machining-ultrasonic micro-machining- laser beam micro-machining - elastic emission micro machining – focused ion beam micro-machining.

Abrasive flow finishing, magnetic abrasive finishing, magnetorheological finishing, magnetorheological abrasive flow finishing, magnetic float polishing – Hybrid finishing processes-chemo mechanical polishing, electro discharge grinding, electrolytic in process dressing grinding.

Introduction – classification – principles, advantages limitations and applications-stereolithography – selective laser sintering – FDM, SGC, LOM, 3D printing - Surface modification techniques: sputtering-CVD-PVD-plasma spraying technique - diffusion coatings - pulsed layer deposition.

Metrology for micro machined components - optical microscopy, white light interferrometry, micro CMM, scanning probe microscopy – scanning electron microscope, transmission electron microscope, atomic force microscope-Tribological characteristics -micro abrasion wear-nano indentation- ellipsometric analysis.

LAB EXERCISES

1) Micro-turning 2) Micro-drilling 3) Electrical discharge micro-machining.

REFERENCES:

1. Jain, V.K “Introduction to Micro-machining”, Narosa publishing house, ISBN: 978-81-7319-915-8, 2010.
2. Jain, V.K, “Micro-manufacturing Processes”, by CRC Press, ISBN: 9781439852903, 2012.
3. Madou, M.J., “Fundamentals of Micro-fabrication: The science of miniaturization”, CRC Press, 2006.
4. Mcgeoug.J.A., “Micromachining of Engineering Materials”, CRC Press, 2001.

5. Kalpakjian.S, “Manufacturing Engineering and Technology”, Pearson Education, 2001.

COURSE OUTCOMES:

1. Understand the principles of various micro and nano manufacturing processes.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓						

PROE19 Introduction to Friction Composites

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To demonstrate knowledge of brake systems principles and operations.
- To identify various raw materials and different types of friction composites.
- To study industrial standard practices in testing the friction composites and brake systems.

Introduction: Laws of friction- types of friction- wear- types of wear- mechanism involved in wear.

Brake system and Assembly: Basic requirements and functions of braking system, Types of brakes, hydraulic brake system, compressed air brake system, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, ABS, EBSD, anti-skid braking system, brake efficiency and testing, weight transfer, braking ratio.

Types of Friction Materials & Applications: Friction Materials -Definition and Nature Overview of types- Organic Friction Materials- Ceramic Friction Materials- Sintered Friction Materials- Applications of friction materials with industrial case studies.

Ingredients & Manufacturing: Raw Materials- Classification of raw materials: Fillers, Binders, Friction Modifiers, Structural Reinforcement- Properties of raw materials - Manufacturing Process– Industrial case studies.

Characterizations: Types of Characterizations: Physical, Chemical, Mechanical, Thermal, Tribological and Microstructural characterization as per industrial standards– case studies.

REFERENCES:

1. Automotive Brake Systems, Robert Bosh GmbH, 1995, First edition, USA.
2. ASM Handbook, Friction, Lubrication, and Wear Technology, Volume18, 1992, USA.
3. Peter J.Blau, Friction Science and Technology- From Concepts to Applications, Second Edition, 2009, CRC Press, USA.
4. Rudolf Limpert, Brake design and safety, II edition, SAE International, Warrendale,1999.

COURSE OUTCOMES:

1. Demonstrate knowledge of brake systems principles and operations.
2. Identify various raw materials and different types of friction composites.
3. Study industrial standard practices in testing the friction composites and brake systems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓					✓			✓
CO2	✓	✓					✓		✓			✓
CO3	✓	✓				✓			✓			✓

PROE20 Green Material Joining and Forming

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To emphasize the importance of green joining and forming methods.
2. To improve sustainability in friction and lubrication in metal forming practice.
3. To emphasize hybrid joining process in sustainable manufacturing.
4. To improve the joining and forming quality.
5. To discuss the development of materials and green lubricants for sustainable manufacturing.

Introduction to Sustainable manufacturing processes: Conventional Manufacturing Processes, Metal Forming Processes, Joining Processes, Sustainable Manufacturing, Sustainable Material Forming and Joining, Computer-Aided Engineering Analyses – Life cycle assessment.

Green Joining: Traditional Joining Methods and Sustainability, Sustainable and Green Joining Methods, Friction-Based Joining Methods, Surface-to-Surface Joining Methods, Laser Welding, Joining of Sheets and Tubes by Plastic Deformation, Computational Analyses and Relevance to Sustainable Joining, Hybrid Joining processes: Hybrid Fusion Welding Processes, Hybrid Solid-State Welding Processes, Hybrid Mechanical Joining Processes, hybrid Joining with Adhesive Bonding, Hybrid Brazing–Soldering–Welding Processes, and Mechanical Joining Processes.

Green Forming: Metal-Forming Process Design, Aspects of Green Forming, Energy Consumption in Hot, Warm, and Cold Forming vs. Green Forming, Number of Forming Stages vs. Green Forming, Amount of Plastic Deformation, Parasitic Energy Loss due to Friction, Minimizing Material Waste toward Green Forming, Indirect Energy Consumption in Material Forming, Continuous Improvement of Quality toward Green Forming, Green Rolling, Thermal Energy Consumption in Rolling Processes, Amount of Plastic Deformation and Roll Forces, Lubrication to Reduce Friction in Rolling, Arrangement of Rolling Mills vs. Green Rolling, Green Forging and Extrusion, Green Wire Drawing, Green Stamping, Some Recent Developments in Microforming, Tubular Hydroforming and Hydropiercing, Hot Stamping of Ultra-High-Strength Steel Parts and Smart Hot Stamping, Laser Metal Forming.

Strategies to Improve the Forming Quality of Sheets: Rolling Method and Conditions, Friction Stir Welding and Processing, Forming at Elevated Temperature, Incremental Sheet Forming, Hydroforming, Sandwich Sheet Formability, Tooling: Flexible Forming and Blank Holding.

Development in Materials for Sustainable Manufacturing: Environmental Impact Assessment, Material Selection, High-Performance Steels, Aluminum Alloys, Magnesium Alloys, Biocomposites, Eco-Materials, Fly Ash, Waste Utilization from Paper and Pulp Industry, Steel - A Sustainable Material of the Future, Green Lubricants and Lubrication.

Sustainability, Health, and Environment – A Case Study of Waste Management Sector.

REFERENCES:

1. R.Ganesh Narayanan, Jay S. Gunasekara, Sustainable material forming and joining, CRC Press, Taylor & Francis Group, ISBN 13: 978-1-138-06020-3, 2019, New York.
2. Davim J, Paulo, Green Manufacturing Processes and Systems (Materials Forming, Machining and Tribology), Springer, ISBN-13: 978-3642431951, 2014.
3. David A. Dornfeld , Green Manufacturing: Fundamentals and Applications (Green Energy and Technology), Springer, ISBN-13: 978-1441960153, 2012.

COURSE OUTCOMES:

1. Identify green joining and forming methods.
2. Improve sustainability in friction and lubrication in metal forming practice.
3. Explore hybrid joining process for sustainable manufacturing.
4. Explore the strategies to improve the joining and forming quality.
5. Apply materials and green lubricants for sustainable manufacturing.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓			✓	✓				✓
CO2	✓	✓	✓	✓			✓	✓	✓			✓
CO3	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
CO4	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓

PROE21 Finite Element Analysis for Solids and Structures

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the need in Design for the Finite Element Methods
- To analyze advanced solid and structural problems, develop finite element procedures for accurately investigating the problem, and effectively perform and document findings

Introduction, Calculus of Variations, methods for solving differential equations, Ritz and Galernkin FEM formulations

Analysis of elastic solids –Mapped solid elements – stress calculation — static condensation -Patch test – computer implementation - Solids of revolution – axisymmetric analysis - unsymmetrical loading

Multifield formulations - beam elements – Euler-Bernouli and Timoshenko theories – displacement based team elements – mixed beam element methods

Multifield formulations - Elastic solids – assumed stress filed for mixed formulations – analysis for nearly imcompressible solids

Plates and shells – Kirchoff's plate theory for rectangular and triangular plate elements –Mindlind plate theory – analysis of shell structure- introduction to non-linear problems.

REFERENCES:

4. M.Asghar Bhatti, "Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations", Wiley; 1 edition, 2003
5. Advanced Topics in Finite Element analysis of structures with Mathematica and Matlab computations, M.Asghar Bhatti, Wiley; 2006
6. Bathe KJ, "Finite Element Procedures", Prentice Hall, 1994

COURSE OUTCOMES:

4. Understand the numerical methods involved in Finite Element Theory and its direct/indirect methods.
5. Understand the FE procedure for solving solids and structures using mulitfiled formulations

6. Perform and verify FEA using commercial FEA software.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓								
CO2	✓			✓								
CO3	✓			✓	✓	✓						✓

ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

PRHO10 Tolerance Technology

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To recognize the importance of tolerances
- To perform tolerance analysis

Introduction to Geometric Dimensioning and Tolerancing, Scope, Definitions, and General Dimensioning, General Tolerancing and Related Principles, Symbology, Datum Referencing, Tolerances of Location, Tolerances of Form, Profile, Orientation, and Runout

Properties of the surface, Principles for tolerancing, Principles for geometrical tolerancing. Profile tolerancing, Tolerancing of cones, Positional tolerancing, Projected tolerance zone, Substitute elements, Maximum material requirement, Envelope requirement, Least material requirement.

Tolerancing of flexible parts, Tolerance chains (accumulation of tolerances), Statistical tolerancing.

General geometrical tolerances, Tolerancing principles, Tolerancing of edges, ISO Geometrical Product Specifications (GPS).

(Use of approved design data book is permitted in the examination)

REFERENCES:

1. Gene R. Cogorno “Geometric Dimensioning and Tolerancing for Mechanical Design”, McGraw-Hill,2006

2. Georg Henzold “Geometrical Dimensioning and Tolerancing for Design, Manufacturing and Inspection-A Handbookfor Geometrical Product Specification using ISOand ASME Standards”, Elsevier, Second edition
3. Bryan R. Fischer “Mechanical Tolerance Stack up and Analysis” Advanced Dimensional Management, Sherwood, Oregon, U.S.A., Marcel Dekker,Inc.
4. ASME “Dimensioning and Tolerancing”,Y14.5M-1994 [REVISION OF ANSI Y14.5M-1982 (RI98811)]

COURSE OUTCOMES:

1. Interpret tolerances.
2. Perform tolerance analysis.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						
CO2	✓		✓			✓						

PRHO11 Robotics

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of robotics
- To perform robot programming

Fundamentals of robotics– wrists design -end effectors – actuators -modular robots. Robot and its peripherals-sensors, machine vision-image processing &analysis-application of artificial intelligence, voice communication-robot control units-motion controls.

Robot kinematics-homogeneous transformations-forward & inverse kinematics-problems of dynamics-differential relationships-motion trajectories-dynamics of a robot control of single multiple link robot-static force analysis.

Robot Programming -different languages-expert systems.

Robot applications in manufacturing-material transfer& machine loading/unloading-processing operations–inspection-automation-robot cell design–control–recent developments and special applications-Micro &Bio robotics.

REFERENCES:

1. Richard D Klafter, Thomas A Chmielewski&Michael Negin,“RoboticEngineering– An Integrated Approach”, PrenticeHall, 1994.
2. Deb, S.R., “RoboticTechnology and FlexibleAutomation”, Tata McGrawHill, 1994.

COURSE OUTCOMES:

1. Apply robotic engineering.
2. Develop programming for robot applications.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓	✓						
CO2	✓		✓	✓	✓	✓						

PRHO12 Intelligent Manufacturing Systems

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of intelligent manufacturing
- To develop knowledge base systems for various applications

Basic concepts of Artificial intelligence and expert systems-System Components-System architecture and Data flow– System Operations

Knowledge based systems-knowledge representation– knowledge acquisition and optimization-Knowledge based approaches to design mechanical parts and mechanisms and design for automated assembly

Knowledge based system for material selection–Intelligent process planning system. Intelligent system for equipment selection-Intelligent system for project management& factory monitoring. Scheduling in manufacturing–scheduling the shop floor–Diagnosis & trouble shooting

The role of Artificial Intelligence in the factory of the future–Intelligent systems.

REFERENCES:

1. Andrew Kussiak,, “Intelligent Manufacturing Systems”, PrenticeHall , 1990.
2. Simons, G.L,“Introducing Artificial Intelligence”, NCC Pub, 1990.

COURSE OUTCOMES:

1. Develop knowledge based systems
2. Apply Artificial Intelligence for automated factories.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓						
CO2	✓	✓	✓		✓	✓						

PRHO13 Total Quality Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To apply TQM principle for continuous process improvement.
2. To evaluate quality production.
3. To utilize modern tool like QFD, FMECA to design and manage the business.

Principles of TQM–Quality Gurus and their contributions–Old and New Quality Control tools-Quality Function Deployment–Failure Modes and Effect Analysis–
Vendor relations–vendor qualification process–vendor quality surveys–Vendor quality improvement–vendor quality rating and evaluation-ISO9000 standards–ISO14000 standards–Quality Costing–Quality Audit–Product and Process audit–Six Sigma–Benchmarking-TQM in Service Sector–Application case studies on TQM.

REFERENCES:

1. Dale H.Besterfield, “Total Quality Management”, Pearson Education Asia, (Indian reprint 2002)
2. Rose, J.E. Total Quality Management, Kogan Page Ltd. 1993.
3. John Bank, The essence of total quality management, PHI1993.
4. Greg Bounds, Lyle Yorks et al., Beyond Total Quality Management, McGraw Hill, 1994.

COURSE OUTCOMES:

1. Apply TQM principle for continuous process improvement
2. Evaluate quality production
3. Utilize modern tool like QFD, FMECA to design and manage the business

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓		✓						
CO2	✓	✓		✓		✓						
CO3	✓	✓		✓	✓	✓						

PRHO14 Product Analysis and Cost Optimization

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To perform value engineering projects.
- To perform cost accounting.

New product strategy, market definition-idea generation-design process-forecasting sales potential-product engineering, manufacturing planning-selection of economical process- standardization -simplification– specialization -break even analysis.

Value engineering – evaluation of function determining function-classifying function-evaluation of costs-evaluation of worth-determining worth-evaluation of value-value engineering.

Job plan information phase-speculation phase-analysis phase-development phase-presentation phase-implementation phase-follow up phase- fast diagramming-cost models- lifecycle costs.

Cost accounting-cost estimation

Cost calculations for machined components, welding, casting and forging components- calculation of selling price – activity based cost analysis.

REFERENCES:

1. Samual Eilon, “Elements of Production Planning and Control”, Universal Book Co, 1984
2. Narang, C.B.S and Kumar V, “Production and Costing”, Khanna Publishers, 1983.

COURSE OUTCOMES:

1. Execute value engineering projects.
2. Cost computation for various fabricated products.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓			✓						
CO2	✓		✓			✓						

PRHO15 Decision Support Systems

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To recognize the importance of decisions in the work and use DSS Software Tools.
2. To evaluate of the Success/Failure of Decision Support Systems
3. To discuss the advantages/disadvantages of different Types of decision support systems and analyze practical cases from the life for different problems (technical, management)

DSS components- Data warehousing, access, analysis, mining and visualization-modeling and analysis-DSS development -Group support systems- enterprise DSS-supply chain and DSS-knowledge management methods, technologies and tools-Artificial intelligence and expert systems- Representation in logic and schemas, semantic networks, production rules and frames, inference techniques – DSS applications.

REFERENCES:

1. Efraim Turban and Jay E Aronson, Decision Support and Intelligent Systems, Pearson education Asia, Seventh edition, 2005.
2. Elain Rich and Kevin Knight, Artificial intelligence, TMH, 2006.
3. VickiL. Sauter, Decision Support Systems for Business Intelligence John Wiley &Sons.
4. Turban, Decision Support And Business Intelligence Systems,8/E, Pearson Education India, 2011.
5. Frada Burnstein, Clyde W.Holsapple.,Handbook on Decision Support Systems Springer, 2008.

COURSE OUTCOMES:

1. Recognize the importance of decisions in the work and use DSS Software Tools.
2. Evaluation of the Success/Failure of Decision Support Systems.
3. Discuss the advantages/disadvantages of different types of decision support systems and analyze practical cases from the life for different problems (technical, management).

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓						
CO2	✓	✓		✓		✓						
CO3	✓					✓						

PRHO16 Knowledge Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To appreciate the role and use of knowledge in organizations and institutions, and the typical obstacles that Knowledge Management aims to overcome.
- To understand the core concepts, methods, techniques, and tools for computer support of knowledge management.
- To understand how to apply and integrate appropriate components and functions of various knowledge management systems.

Knowledge society- Drivers of knowledge management-Intellectual capital- KM and learning organizations-Strategic alignment- Evaluation and strategic alignment-Infrastructural development and deployment- Role of CKO-Analyzing business environment-knowledge audit and analysis – designing KM team, system–Technology components- Intranet and Groupware solutions- tools for collaborative intelligence-Social networking-package choices- knowledge security-Integrating with web -based and internal operational & support systems- change management- reward systems-continuous improvement – Intellectual Property Rights.

REFERENCES:

1. Guus Schreiber, Hans Akkermans, Anjo Anjewierden, Robert de Hoog, Nigel Shadbolt, Walter Vande Velde and Bob Wielinga, “Knowledge Engineering and Management”, Universities Press, 2004.
2. Elias M. Awad & Hassan M.Ghaziri,“Knowledge Management”, Pearson Education, 2004.

COURSE OUTCOMES:

1. Appreciate the role and use of knowledge in organizations and institutions, and the typical obstacles that Knowledge Management aims to overcome.
2. Understand the core concepts, methods, techniques, and tools for computer support of knowledge management.
3. Understand how to apply and integrate appropriate components and functions of various knowledge management systems.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓	✓					
CO2	✓				✓	✓	✓					

CO3	✓					✓	✓					

PRHO17 Product Life Cycle Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand product lifecycle management strategies
- To recognize PLM integration with other functions

New Product Development, Introduction to PLM, Product Data Management(PDM), Views of PLM, PLM Strategies and its Development, Product Design Modeling and simulation in product design. Integration of PLM with other applications, Technology, Forecasting, Virtual product development tools, Product structures

REFERENCES:

1. Antti Saaksvuori, AnselmiImmonen, “Product Lifecycle Management”, Springer, 2005
2. John Stark, “Product lifecycle management: 21st century paradigm for product realization”, Springer 2006
3. Michael Grieves, “Product lifecycle management: Driving the next generation of lean thinking”, McGraw-Hill, 2006

COURSE OUTCOMES:

1. Understand PLM applications.
2. Develop product data management tools.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓						
CO2	✓		✓	✓	✓	✓						

PRHO18 Technology Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To develop an awareness of the range, scope, and complexity of technological innovation, and the issues related to managing technological change.
2. To understand different approaches to manage innovation, with multi-criteria decision making techniques
3. To identify drivers and barriers to technological innovation within an organization.

Definition-scope-components -Issues in managing new technology, Life cycle approach to technology Management-Approaches to forecasting, Technology performance parameters. Use of Experts in technology forecasting, planning technological process, Morphological analysis of a Technology system-Techno-Economic feasibility study, Application of multi-criteria decision making techniques in technologies evaluation and selection-AHP, fuzzy AHP-Modes of global technology transfer-Technology–Human Interface-Organization structures and Technology Implementation issues in new technology – Technology Management issues in the context of lean, agile and sustainable systems – Intellectual Property Rights.

REFERENCES:

1. Joseph M. Putti, Management– A Functional Approach, McGraw Hill, 1997
2. Kenneth C. Lauden , MIS: Organisation and Technology, Prentice Hall, 1995
3. James A.Senn, Information technology in Business, Prentice Hall, 1995
4. Ronald J. Jordan, Security analysis and Portfolio Management, Prentice Hall, 1995.

COURSE OUTCOMES:

1. Develop an awareness of the range, scope, and complexity of technological innovation, and the issues related to managing technological change.
2. Understand different approaches to manage innovation, with multi-criteria decision making techniques
3. Identify drivers and barriers to technological innovation within an organization.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓						
CO2	✓					✓						

CO3	✓					✓						

PRHO19 Multi-Criteria Decision Making Techniques

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To recognize the need for Multi-criteria decision making
- To understand various MCDM methods

Multi-Criteria Decision Making – An Overview – Classification of MCDM methods – Simple Additive Weighting method – Weighted Product method - Network based MCDM methods – Analytic Hierarchy Process – Revised Analytic Hierarchy Process – Analytic Network Process - Outranking MCDM methods – PROMETHEE , ELECTRE , TOPSIS - Compromise Ranking method - VIKOR, ORESTE – DEMATEL - Fuzzy based MCDM methods – Hybrid MCDM methods – Group Decision Making- Graph Theory and Matrix approach – Goal Programming – Balanced Scorecard Approach - MCDM application areas – Case studies on application of MCDM techniques.

REFERENCES:

1. Belton, V., Stewart,T.J.Multiple Criteria Decision Analysis: An Integrated Approach, Kluwer Academic Publishers, Dordrecht, 2003.
2. Triantaphyllou, E., Multi-Criteria Decision Making Methods: A Comparative Study, Springer, 2010.
3. Pedrycz, W., Ekel, P., Parreiras, R., 2011.Fuzzy Multi Criteria Decision-Making: Models, Methods and Applications, John Wiley & Sons, 2011.
4. Kahraman,C.,Fuzzy Multi-criteria Decision Making: Theory and Applications with Recent Developments, Springer, 2008.

COURSE OUTCOMES:

1. Understanding of various MCDM methods.
2. Apply MCDM methods for real time applications.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓						
CO2	✓	✓	✓			✓						

MINOR (MI)

PRMI10 Manufacturing Processes

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand basic manufacturing processes like casting and welding
- To study various metal forming processes
- To understand the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping, milling, drilling and grinding machine.
- To demonstrate the fundamentals of machining processes and machine tools.

CASTING: Types of pattern - Types of cores - Green Sand Molding - Tools and equipment - Cupola and Blast Furnaces

WELDING: Welding Principle and Types - Gas Welding – GMAW – TIG – MIG – Plasma Welding – Resistance Welding - Friction welding

FORMING: Classification of Forming – Forging and its Types – Upsetting –Extrusion of Solid Rod – Rolling of Plate – Drawing of wire – Sheet metal operations

MACHINE TOOL: Studies on Centre Lathe – Drilling – Milling– Shaper – Grinding

MACHINING: SPCT geometry – Orthogonal Cutting – Machining cylindrical Job –Gear Cutting –Taper turning and Thread Cutting Methods

REFERENCES:

1. Nagendra Parashar, and Mittal, R.K, Elements of manufacturing processes, Prentice Hall of India PrivateLimited,1st Edition,2003
2. Hajra Choudhury SK, Bose HK and Hajra Choudhury AK, Elements of Workshop Technology, Vol .I , Vol.II,Media promoters and Publishers Pvt. Ltd. 12thEdition,2007.
3. Khanna,O.P and Lal, M,A Text book of Production Technology, Vol.II, Dhanpat Rai Publications (P)ltd.,1stEdition, 2009.
4. H.M.T, Production Technology, Tata McGrawHill Publishing Co.Ltd, 1stEdition, 2008.
5. ASM Handbook, Machining.

COURSE OUTCOMES:

1. Demonstrate understanding of casting process and analyze the welding process behavior for common and newer welding techniques
2. Recognize the various metal forming techniques

3. Understand the concept and basic mechanics of metal cutting and conventional machines.
4. The working of standard machine tools such as lathe and demonstrate the need of such machine tools for sustainable development

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓			✓				✓
CO2			✓	✓		✓			✓	✓	✓	
CO3	✓		✓									✓
CO4				✓			✓		✓			

PRMI11 **CAD, CAM and CAE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand geometric modeling and graphic standards of CAD systems
- To understand basics of CAM
- To understand finite element modeling and DBMS

Basic concepts of CAD, CAD workstation, CAD software, application of CAD, Interactive graphics: point plotting techniques, Transformations techniques, viewing operations.
Geometric modeling: Wireframe modeling, Surface modeling, Solid modeling. Graphics standards, Parametric design, Visual realism.
Computer aided manufacturing: NC/CNC, computer aided process monitoring - adaptive control, computer-aided process planning.
Production planning - capacity planning - shop floor control - computer integrated manufacturing systems, application.
Finite element modeling and analysis: types of analysis, degrees of freedom, element and structure-stiffness equation, assembly procedure. Database concepts and data base management systems - SQL.

LAB EXERCISES: Part modelling using CAD, Turning operation using CNC, Engineering analysis using CAE

REFERENCES:

1. Anand, V.B., Computer Graphics and Geometric Modeling for Engineers, John Wiley and Sons, Inc., 2000.
2. Zeid,I and Sivasubramanian, R., CAD/CAM, Tata McGraw-Hill, 2007.
3. Mikell P. Groover and Emory W. Zimmers, Jr., CAD/CAM Computer Aided and Manufacturing Eastern Economy Edition,PHI
4. Larry J Segerlind ,“ Applied Finite Element Analysis”, John Wiley, 1984
5. YoramKoren, "Computer Control of Manufacturing Systems", McGraw Hill Book co. New Delhi, 1986.

COURSE OUTCOMES:

1. Summarize the concepts and applications of CAD and modelling.
2. CNC code generation for CNC Turning.

3. Finite element analysis using software.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓	✓	✓	✓						
CO3	✓		✓	✓	✓	✓						✓

PRMI12 Unconventional Manufacturing Processes

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand several non-traditional machining process in micro and precision manufacturing field.
- To select advanced manufacturing processes of materials.

Introduction - Classification - process economy - Mechanical machining - Types - Ultrasonic machining (USM) - Abrasive Jet Machining (AJM) - Abrasive Flow Machining (AFM) - Water Jet Machining (WJM) - Operating principle - Process parameters - Applications - Limitations.

Electro chemical machining - Chemical material removal - Types - Electro chemical machining (ECM) - Electro chemical drilling (ECD) - Electro chemical grinding (ECG) - Electro chemical honing (ECH) - Shaped tube electrolytic machining - Operating principle - Process parameters - Applications - Limitations.

Thermo electrical machining - Types – Electrical discharge machining (EDM) - Electrical discharge wire cutting (EDWC) - Electron beam machining (EBM) - Ion Beam Machining (IBM)-Plasma Arc Machining (PAM) - Operating principle - Process parameters - Applications – Limitations

Laser materials processing - Laser types - Processes - Laser beam machining (LBM) – Laser cutting (LC) – Laser drilling (LD) - Laser marking and engraving (LM) - Laser micromachining (LMM) - Laser engineered net shaping (LENS) - Applications - Limitations.

Special processing technologies - Rapid Prototyping - Methods - Fused Deposition Modeling (FDM) - Laminated Object Manufacturing (LOM) - Selective laser sintering (SLA) - Solid Ground curing (SGC) - 3D printing (3DP) - Processing of integrated circuits - Micro and nano fabrication technologies.

REFERENCES:

1. Abdel, H. and El-Hofy, G. “Advanced Machining Processes”, McGraw-Hill, USA, 2005.
2. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi, 2007.
3. Benedict. G.F. “Nontraditional Manufacturing Processes” Marcel Dekker Inc., New York, 1987.

4. McGeough, “Advanced Methods of Machining” Chapman and Hall, London (1998).
5. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, “Material and Processes in Manufacturing” 8thEdition, Prentice Hall of India Pvt. Ltd., New Delhi , 2001.
6. Groover, M.P. “Fundamentals of modern manufacturing processes - Materials, Processes and Systems”, 3rd Edition, John Wiley and Sons Inc., 2007.

COURSE OUTCOMES:

1. Understand several non-traditional machining processes in micro and precision manufacturing field.
2. Select advanced manufacturing processes of materials.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓		✓						✓
CO2	✓			✓		✓						✓

PRMI13 Industrial Engineering and Management

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of Industrial Engineering, Operational Research Techniques, Simulation, Supply Chain Management and Quality Engineering.

Introduction to Industrial Engineering – Method study, Time study, Motion Economy, Value Analysis, Demand Forecasting, Scheduling

Production Planning and Control - Inventory Control, Material Requirement Planning, Aggregate Planning, Material Handing, Group technology, Facility planning, Design of Product and Process Layouts.

Supply Chain Management - Understanding the Supply Chain, Achieving Strategic Fit, Drivers and Metrics, Designing the Supply Chain Network - Managing Cross Functional Drivers in a Supply Chain.

Operational Research Techniques – Linear Programming, Transportation, Assignment models, Queuing Theory, Simulation.

REFERENCES:

1. Sunil Chopra and Peter Meindel , Supply Chain Management: Strategy, Planning, and Operation, Prentice Hall of India, 2002.
2. R.Paneerselvam, Production and Operations Management, (3rd edition) PHI Learning Pvt Ltd,2012.
3. Jerry Banks, Discrete Event System Simulation, Prentice Hall ,2010.
4. Hamdy A. Taha, Operations Research an Introduction, Prentice Hall ,1997.
5. O.P.Khanna, Industrial Engineering and Management, Dhanpat Rai, 1980.

COURSE OUTCOMES:

1. Summarize different techniques for production planning and control like inventory control and Material requirement.
2. Apply optimization in utilization of resources like queuing uncertainty and mathematical modeling are involved
3. Perform work measurements and computerized layout planning

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓	✓	✓	✓						

CO3	✓		✓	✓	✓	✓						

PRMI14 Quality Engineering

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge to enable the students to design and implement Statistical Process Control in any industry.
- To design and implement acceptance sampling inspection methods in industry.
- To achieve savings in rupees to the companies through quality control and improvement programmes.

QUALITY FUNDAMENTALS

Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance- areas of quality- quality planning- quality objectives and policies quality costs- economics of quality- quality loss function- Quality Gurus and their contributions.

CONTROL CHARTS FOR VARIABLES

Process variation- preliminary decisions- control limits and their computation- construction and application of X bar, R and S charts- warning and modified control limits- process adjustment for trend,- Comparison of process variation with specification limits

STATISTICAL PROCESS CONTROL

Process stability- process capability study using control charts- capability evaluation- Cp, Cpk and Cpm – machine capability study- gauge capability study- setting statistical tolerances for components and assemblies - individual measurement charts- X-chart, moving average and moving range chart.

CONTROL CHARTS FOR ATTRIBUTES

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

ACCEPTANCE SAMPLING

Need- economics of sampling- sampling procedure- single and double sampling- O.C. curves-Average outgoing quality- Average sample number- Average total inspection- Multiple and sequential sampling- Design of sampling plans.

REFERENCES:

1. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, John Wiley & Sons, 2004.
2. Krishnaiah K.,” Applied Statistical Quality Control and Improvement”, PHI, 2014.
3. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, TMH, Seventh Edition, 2000.
4. Dale H. Besterfield, Quality Control, Pearson Education Asia, Seventh Edition, 2004.

COURSE OUTCOMES:

1. Control the quality of processes using control charts for variables in manufacturing industries.
2. Control the occurrence of defects in services.
3. Achieve savings in rupees to the companies through quality control and improvement programmes.

MAPPING OF PROGRAMME OUTCOMES WITH COURSE OUTCOMES:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						
CO2	✓		✓			✓						
CO3	✓		✓			✓						