Teaching Scheme for B.E. Production and Industrial Engineering
(Courses/Credit Distribution) (2021-22)

FIRST YEAR

Semester I

Course Code	Subject	Credits	L	T	P	Category
OR1101	Orientation (1 Credit) + PR7001 (Introduction to P & I (1 Credit)	2				
MA1101	BSC-I (Mathematics: Calculus & Ordinary DE)	4	3	1	0	BSC
PY1101/CH1201	BSC- II (Physics (Mechanics & Optics) /OR BSC-IV (Chemistry: Applied Chemistry II)	4	3	0	2	BSC
GS1101/GS1201/ ES1101	GSC-I & GSC-II (Intr. to Environmental Sc.) / OR ESC-I (Introduction to Computing)	4	2/3	0	2	GSC/ESC
HS1101 / ES1201	HSM-I (Communication Skill & Ethics)/ OR ESC-II (Engineering Drawing & CAD)	3	2	0	2	HSM/ESC
ES1301/ES1401	ESC-III(Introduction to Mechatronics / OR ESC-IV (Introduction to EC & EE)	3/2	2	0	2/0	ESC
	Total	20/19				

Semester II

Course Code	Subject	Credits	L	T	P	Category
MA1301	BSC-III (Mathematics: Probability & Statistics)	4	3	1	0	BSC
CH1201/ PY1101	BSC- IV (Chemistry: Applied Chemistry II / OR BSC-II (Physics: Mechanics & Optics)	4	3	0	2	BSC
ES1101GS1201/ GS1101	ESC-I (Intr. to Computing) / OR GSC-I & GSC-II (Intr. to Environmental Sc.)	4	3/2	0	2	ESC/GSC
ES1201/ HS1101	ESC-II (Engineering Drawing & CAD) / OR HSM-I(Communication Skill & Ethics)	4	2	0	2	ESC/HSM
ES1401/ ES1301	ESC-IV (Intr. to EC & EE) / OR ESC-III (Intr. to Mechatronics)	2/3	2	0	2/0	ESC
ES1601	ESC-VI (Strength of Materials)	2	2	0	0	ESC
	Total	19/20				

SECOND YEAR

Semester III

Course Code	Subject	Credits	L	T	P	Category
ES1701/ HSM II	ESC-VII (Artificial Int. & Mc Learning)/ HSM II	3				ESC/HS
PR1001	Kinematics & Dynamics	3	2	0	2	DCC
PR1002	Engineering Economics	3	2	1	0	DCC
PR1003	Manufacturing Processes-I	3	2	0	2	DCC
PR1004	Manufacturing Processes-II	3	2	0	2	DCC
PR6XXX	Open Elective Course-I	4	3	1	0	OE
PR1201	Industrial Tour	2				
	Total	21				

Semester IV

Course Code	Subject	Credits	L	T	P	Category
PR1005	Manufacturing Processes-III	3	2	0	2	DCC
PR1006	Machine Drawing & Tool Design	4	2	0	4	DCC
PR1007	Production & Operations Management	3	3	0	0	DCC
PR1008	Industrial Engineering-I	3	2	0	2	DCC
PR6XXX	Open Elective Course-II	4				OE
HSM II / ES1701	HSM II / ESC-VII (Artificial Int. & Mc Learning)	4				HS/ESC
PCXXX	Proficiency-I	2				
	Total	23				

THIRD YEAR

Semester V

Course Code	Subject	Credits	L	T	P	Category
PR1009	Operations Research	3	2	1	0	DCC
PR1010	Computer Integrated Manufacturing& Metrology	3	2	0	2	DCC
PR1011	Industrial Engineering-II	3	3	0	0	DCC
PR1012	Design of Machine Elements	3	2	0	2	DCC
PR2XXX	Department Elective Course I	4				
PR2XXX	Department Elective Course-II	4				DEC
PR1301	Minor Project	2				DCC
	Total	22				

Semester VI

Course Code	Subject	Credits	L	T	P	Category
PR1202	Internship (Optional) *	12				DCC
	Students opting for course work will do Dept. Electives (4 Cr), Open elective (4 Cr), Project work (4 credits)					
	Total	12				

*Internship Seminar presentations may be held a week before the date of Registration in Semester-I of 4th Year

FOURTH YEAR

Semester VII

Course Code	Subject	Credits	L	T	P	Category
HSXXX	HSM-III	3				HSM
PR2XXX	Department Elective Course-III	4				DEC
PR2XXX	Department Elective Course-IV	4				DEC
PR1302	Major Project-I	2*				DCC
PR6XXX	Open Elective Course-III	4				OE
PR6XXX	Open Elective Course-IV	4				OE
	Total	21				

*Evaluation needs to be carried out in next semester

Semester VIII

Course Code	Subject	Credits	L	T	P	Category
HSXXX	HSM-IV	3				HSM
PR2XXX	Department Elective Course-V	4				DEC
PR6XXX	Open Elective Course-V	4				OEC
PR6XXX	Open Elective Course-VI	4				OEC
PR8001	Discipline	2				
PCXXX	Proficiency-II	2				
PR1303	Major Project-II	4				DCC
	Total	23				

*** L-T-P (Lecture-Tutorial-Practical)**

I. Department Core Courses (DCC)

Course Code	Course Name	Credits	L	T	P
PR1001	Kinematics & Dynamics	3	2	0	2
PR1002	Engineering Economics	3	2	1	0
PR1003	Manufacturing Processes-I	3	2	0	2
PR1004	Manufacturing Processes-II	3	2	0	2
PR1005	Manufacturing Processes-III	3	2	0	2
PR1006	Machine Drawing & Tool Design	4	2	0	4
PR1007	Production and Operations Management	3	3	0	0
PR1008	Industrial Engineering-I	3	2	0	2
PR1009	Operations Research	3	3	0	0
PR1010	Computer Integrated Manufacturing and Metrology	3	2	0	2
PR1011	Industrial Engineering-II	3	3	0	0
PR1012	Design of Machine Elements	3	2	0	2

II. Departmental Elective Courses (DEC)

Course Code	Course Name	Credits	L	T	P
PR2001	Additive Manufacturing	4	3	0	2
PR2002	Supply Chain Management	4	3	1	0
PR2003	Advanced Operation Research	4	3	1	0
PR2004	Knowledge Based Systems in Engineering	4	3	1	0
PR2005	Advanced Foundry Technology	4	3	0	2
PR2006	Advanced Welding Techniques	4	3	0	2
PR2007	Industrial Tribology	4	3	1	0
PR2008	Theory of Metal Cutting	4	3	1	0
PR2009	Non Destructive Testing	4	3	1	0
PR2010	Materials Characterization	4	3	0	2
PR2011	Design & Manufacturing of Composites	4	3	1	0
PR2012	Machine Tool Design	4	3	1	0
PR2013	Advanced Manufacturing Processes	4	3	0	2
PR2014	Thermal Engineering	4	3	1	0
PR2015	Modelling& Simulation	4	3	1	0
PR2016	Data Mining and Big Data	4	3	0	2
PR2017	Finite Element Method	4	3	1	0
PR2018	Smart Materials	4	3	1	0
PR2019	Maintenance Management	4	3	1	0
PR2020	Optimization Techniques in Mfg.	4	3	1	0
PR2021	Design for Manufacturing	4	3	1	0
PR2022	Special Topics in Industrial Engg. (Business Process, Reverse Engg., 6 σ, Lean, Agile)	4	3	1	0
PR2023	Industrial Hazards and Safety	4	3	1	0
PR2024	Engineering Analysis and Design	4	3	1	0
PR2025	Sensor Manufacturing and Process control	4	3	1	0
PR2026	Enterprise & Cyber Security in Mfg.	4	3	1	0

*** For Honors, the students are required to choose additional subjects of 16 credits from the DepartmentalElective courses**

III. Open Elective Courses (OE)

Course Code	Course Name	Credits	L	T	P
PR6001	Supply Chain Management	4	3	1	0
PR6002	Additive Manufacturing	4	3	0	2
PR6003	CNC Machines and Programming	4	3	0	2
PR6004	Advanced Manufacturing processes	4	3	0	2
PR6005	Advanced Ergonomics & Work design	4	3	0	2
PR6006	Finite Element Method	4	3	1	0
PR6007	Value Engineering	4	3	1	0
PR6008	Quality Management System	4	3	1	0
PR6009	Technology Management	4	3	1	0
PR6010	Product Design & Development	4	3	1	0
PR6011	Design for Automation	4	3	0	2

*** Note: A maximum of 60 students shall be accommodated for the selective OE run inanyparticular semester**

IV. Major Specialization in Production & Industrial

Digital Manufacturing (Any four Courses)

Course Code	Course Name	Credits	L	T	P	Specialization
PR4001	Additive Manufacturing	4	3	0	2	**Digital Manufacturing**
PR4002	Industry 4.0 & IOT	4	3	0	2	
PR4003	Design for Automation	4	3	0	2	
PR4004	Finite Element Method	4	3	1	0	
PR4005	Industrial Robotics	4	3	0	2	
PR4006	CNC Machining & Programming	4	3	0	2	
PR4007	Creativity in Engineering	4	3	1	0	
PR4008	Computer Graphics & Product Modelling	4	3	0	2	

System Engineering (Any four Courses)

Course Code	Course Name	Credits	L	T	P	Specialization
PR4101	Advance Ergonomics & Work Design	4	3	0	2	**System Engineering**
PR4102	Value Engineering	4	3	1	0	
PR4103	Flexible Manufacturing System	4	3	1	0	
PR4104	Concurrent Engineering	4	3	1	0	
PR4105	Materials Management	4	3	1	0	
PR4106	Technology Management	4	3	1	0	
PR4107	Quality Management System	4	3	1	0	
PR4108	Product Design & Development	4	3	1	0	

*** The students who choose 4 courses from above individual basket electives (Digital Mfg./ System Engg.) will get a Major degree in the particular specialization.**

V. Minor Specialization in Production & Industrial

Compulsory Subjects

Course Code	Course Name	Credits	L	T	P	Remarks
PR5001	Supply Chain Management	4	3	1	0	**Compulsory Subjects**
PR5002	Manufacturing Processes	4	3	0	2	

Optional1 (Any one)

Course Code	Course Name	Credits	L	T	P	Remarks
PR5101	Additive Manufacturing	4	3	0	2	**Out of 4, any one subject can be chosen**
PR5102	CNC Machines and Programming	4	3	0	2	
PR5103	Advanced Manufacturing Processes	4	3	0	2	
PR5104	Theory of Metal Cutting	4	3	1	0	

Optional2 (Any one)

Course Code	Course Name	Credits	L	T	P	Remarks
PR5201	Advanced Ergonomics & Work design	4	3	0	2	**Out of 4, any one subject can be chosen**
PR5202	Value Engineering	4	3	1	0	
PR5203	Quality Management System	4	3	1	0	
PR5204	Technology Management	4	3	1	0	

*** The students need to choose total 4 courses as indicated above (2 from Compulsory and 2 from optional subject list) to get a Minor specialization**

Course Name	**:**	**INTRODUCTION TO MANUFACTURING**
Course Code	**:**	**ES1501**
Credit	**:**	**2**
L T P	**:**	**2-0-0**

Course Objectives:
To understandand classify manufacturing processes; their principles and applications

Total Number of lectures: 28

S. No.	Course Contents	Number of Lectures
1.	Concept of Manufacturability, Classification of Manufacturing processes -Introduction to Primary Manufacturing processes: Types and applications -Introduction to Secondary and Tertiary Manufacturing processes: Types and applications.	**6**
2.	Concept of Smart, Digital and Sustainable manufacturing processes with applications. Concepts of Industry 4.0 its relevance and Industrial Internet of Things (IIOT).	**6**
3.	Introduction to Advanced Manufacturing and Hybrid Manufacturing Processes: Classification, Working principles, Advantages, Limitation and applications.	**6**
4.	Computer Integrated Manufacturing: Concept of CAD/ CAM. -Concept of Additive and Subtractive manufacturing processes: -Rapid Prototyping & Rapid Manufacturing, Principles, Major technologies used and its applications. -CNC machines, concepts, uses and applications. -Industrial Robots, types and applications.	**6**
5.	Case studies and practical examples on: (a) Manufacturing of small precision parts (b) Manufacturing of ICs & PCB. (c) Manufacturing of keyboards and hardware.	**4**

Course Outcomes:	
1	Students would be able to choose a particular precision/ advanced manufacturing process for typical applications.
2	Understand the process and applications of Rapid Prototyping
3	Understand the concepts and applications of CNC machines.

Bibliography:

S.No.	Name Of Book / Authors / Publishers	Year Of Publication
1	Manufacturing Engineering & Technology, SeropeKalpakjianand Steven R. Shmid, Prentice Hall, (Pearson Publications)	2009
2	Advanced Manufacturing Processes, VK Jain, Allied Publishers	2011
3	Introduction to Basic Manufacturing, CS Jawalkar, Narosa Publishers	2016

Course Name	**:**	**KINEMATICS AND DYNAMICS OF MACHINES**
Course Code	**:**	**PR1001**
Credit	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:	
1	To provide basic concepts of kinematic and dynamic analysis of machines & its elements
2	The students will be able to study, understandand apply concepts of governors and balancing mechanisms

Total Number of lectures: 28

S. No.	**Course Contents**	**Number of Lectures**
6.	**INTRODUCTION** Basic Concept Of Machines, Link, Kinematics Pair, Kinematics Chain, Mechanism Inversions For Kinematics Chains, Slider Crank Chains & Its Inversions, Quick Return Mechanisms.	**3**
7.	**MOTION ANALYSIS OF MECHANISMS** Absolute And Relative Motions, Motion Of Link, Four Link Mechanism, Linear And Angular Velocities Of Links, Instantaneous CenterOf Rotation Of Body, Kennedy's Theorem, Acceleration Analysis.	**4**
8.	**BELTS** Materials, Types Of Drives, Idle Pulley, Intermediate Or Counter Shaft Pulley, Velocity Ratio, Laws Of Velocity Ratio, Crowning Of Pulleys, Loose And Fast Pulleys, Law Of Belting, Belt Length, Ratio of Tension on Tight And Slack Side Of Belt, HP Transmitted.	**4**
9.	**GEARS** Classification and Basic Terminology, Fundamental Law of Gearing, Cycloidal and Involute Profiles, Standards in Tooth Forms, Spur Gears and Other Types Of Gears, Path Of Contact, Arc Of Contact.	**4**
10.	**CAMS** Displacement, Velocity And Acceleration Diagrams, Profile Of Cams, Determination Of Maximum Velocity And Acceleration Of Follower, Types Of Cams, Cams With Reciprocating And Oscillating Followers, Layout Of Cam Profiles.	**4**
11.	**BALANCING** Static Balancing, Dynamic Balancing, Balancing of Rotating Masses, Balancing of Reciprocating Masses, Force Balancing of Linkages, Balancing of Locomotives.	**4**
12.	**GOVERNORS** Types Of Governors, Terms Used In Governors, Watt, Porter, ProellAndHartnell Governor, Sensitiveness Of A Governor	**5**

Course Outcomes:	
1	Able to analyse the motion of various mechanisms of machine tools.
2	Able to select the suitable mechanism for different applications in designing of machine tools.

3	Able to apply the knowledge of various components like flexible connectors (Belts, Ropes and Chains), rigid connectors (Gears), Cams and Governors.
4	Able to find the solution for various problems likely to be generated by vibrations due to unbalancing of machine elements and fluctuation of speed and energy.

S. No.	**List of Experiments**	**Number of Hours**
1	To find displacement, velocity and acceleration of slider in a single slider crank mechanism for different crank angles and draw graphs between x,y and f v/s φ	**2**
2	To study various inversions of kinematic chains	**2**
3	Balance experimentally the known unbalanced force due to a rotating weight by introducing two balancing weights in two different planes (a) balancing planes on either side of unbalanced force (b) balancing planes on the same side of unbalanced force.	**3**
4	Find out the positions of the four weight, so that the system becomes statically &dynamically balanced	**2**
5	Study of the interference under cutting	**2**
6	Determination of characteristics curve of the following governors: watt governor, porter governor, Proell governor, Hartnell governor	**3**

Bibliography:

S.No.	**Name Of Book / Authors / Publishers**	**Year of Publication**
1	"Theory Of Machines And Mechanisms", P L Ballaney, Khanna Publications	2014
2	"Theory Of Machines" S Rattan, Tata McGraw Hill	2009
3	"Theory Of Machines And Mechanisms", Joseph Edward Shiegley& John Joseph Uicker, Mcgraw Hill Book Company	1988

Course Name	**:**	**ENGINEERING ECONOMICS**
Course Code	**:**	**PR1002**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:	
1	To expose the students to in various methods of computation, cost analysis and replacement studies, which are the essential tools for an Industrial engineer.
2	At the end of the course the students should be able to use these methods/tools in actual industries

Total Number of Lectures: 28

S. No.	**Course Contents**	**Number of Lectures**
1.	**INTRODUCTION** Nature And Purpose Of Engineering Economy Studies Functions Of Engineering Economy, Physical And Economic Laws, Consumer And Producer Goods.	**2**
2.	**INTEREST AND DEPRECIATION** Productivity Of Capital, Nominal And Effective Interest, Interest Factors, CAF, PWF, SPWF, SCAF, SFF, And CRF, Defer Red Annuities, Perpetuities And Capitalized Cost, Equivalence, Gradient Factors GPWF And GUSF, Classification Of Depreciation, Methods Of Computing Depreciation, Economic Life And Mortality Data, Capital Recovery And Return.	**7**
3.	**INDUSTRIAL COSTING AND COST ANALYSIS** Classification of Costs: Direct Material, Direct Labor and Overheads, Fixed And Variable Cost, Semi-Fixed Cost, Increment, Differential And Marginal Cost, Sunk Cost And Its Reasons, Direct And Indirect Cost, Prime Cost, Factory Cost, Production Cost And Total Cost. Break-Even Analysis, Two And Three Alternatives, Graphical Solution, Break-Even Charts, Effects Of Changes In Fixed And Variable Cost, Minimum Cost Analysis, Economic Order Quantity, Effect Of Risk And Uncertainty On Lot Size.	**5**
4.	**REPLACEMENT STUDIES** Reason Of Replacement, Evaluation Of Proposals, Replacement Because Of In Adequacy, Excessive Maintenance, Declining Efficiency, Obsolescence; MAPI Formula.	**4**
5.	**COST ESTIMATION AND RISK ANALYSIS** Difference Between Cost Estimation and Cost Accounting, Qualification So Fan Estimator, Estimating Procedure, Estimate Material Cost and Labor Cost, Estimation of Cost in Machining, Forging, Welding and Foundry Operations. Introduction to Risk Analysis, Measures of Risk, Techniques of Risk Analysis; RAD and CE Approach. Budget and Balance Sheet	**7**
6.	**ECONOMY STUDY PATTERNS** Basic Economy Study Patterns And Their Comparison, Effect Of Taxation On Economic Studies.	**3**

Course Outcome:	
1	At the end of the course student will be able to understand industrial costing and able to analyze cost.
2	At the end of the course student will be able to do cost estimation and perform risk analysis after understanding uncertainty.

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Economic and Financial Analysis for Engineering and Project Management" Ardalan, A.,CRC Press	1999
2	"Principles of Engineering Economy", Grant, E.L.,Grant,W. and Leaven worth, R.S., 8thEd., John Wiley & Sons Inc	2001
3	"Engineering Economy by Applying Theory to Practice (Engineering Technology)", Eschenbach,T.G.,2ndEd., Oxford University Press, USA	2003
4	"Engineering Economy", Blank, L.T., and Tarquin, A.J., McGraw-Hill Inc.	2005
5	"Engineering Economy and the Decision-Making Process", Hartman,J.C., Prentice Hall Inc.	2006
6	"Engineering Economy" Theusen GeraldJ., FabryckyW.J., PHI	2008
7	"Engineering Economics", R. Panneerselvam, PHI	2012

Course Name	**:**	**MANUFACTURING PROCESSES-I**
Course Code	**:**	**PR1003**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:	
1	The students will be able to study and understand the basic elements, classification and applications of some important conventional machines like lathes, shapers, milling, drilling and grinding
2	The students will be able to understand the principles of some non-conventional machining technologies.

Total Number of Lectures – 28

S. No.	**Course Contents**	**Number of Lectures**
1.	**INTRODUCTION** Classification of M/c Processes, Kinds of Motions in M/c tools, Tool materials & Cutting fluids	**2**
2.	**LATHE & LATHE OPERATIONS** Classification of Lathes, Capstan and Turret Lathes, Geometry of A Single Point Cutting Tool; Effect of Different Angles and Cutting Parameters. Lathe Operations Such as: Facing, Tapering Parting, Chamfering, Threading, Knurling and Calculations On Machining Times.	**4**
3.	**DRILLING MACHINES** Classifications, Nomenclature Of A Drill, Drilling Operations Such As Boring, Reaming, Tapping, Speed, Feed & M/C Time Calculations	**2**
4.	**MILLING M/C** Classifications, Specs, Indexing Devices, Up Milling & Down Milling, Milling Attachments, Cutter Geometry, Speed, Feed & M/C Time Calculations.	**3**
5.	**GRINDING MACHINES** Classifications & Applications. Surface, Internal & Centre-Less Grinding, Wheel Selection, Standards, M/C Times. Dressing & Truing Of Grinding Wheels	**2**
6.	**SHAPING, PLANING AND BROACHING** Types & Classification of Shapers, Planers, Specifications, QRM, Speed, Feed & Machining Time Calculations. Job Holding Devices & Applications. Broaching Tools And Parameters.	**3**
7.	**THORY OF METAL CUTTING** Types Of Chips, Mechanics Of Chip Formation, Relevance Of Shear Angle, Merchant Circle, Lee & Shafer's Theory, Forces In Turning, Drilling & Milling, Tool Life And Mechanism Of Tool Failures.	**3**
	NON CONVENTIONAL MACHINING PROCESSES	

8.	Classifications, Applications and Limitations. Principle And Applications Of: Abrasive Jet, Water Jet, Ultrasonic Machining, Electro-Chemical M/C Electric Discharge M/C, Electron Beam M/C, Laser Beam M/C, Plasma Arc Machining Electro-Chemical Grinding, Chemical M/C And Abrasive Flow Machining	**5**
9.	**HIGH VELOCITY METAL FORMING** Electro-Hydraulic Forming, Mechanical High Velocity Forming, Magnetic Pulse Forming & Explosive Forming	**2**
10.	**GEAR MANUFACTURING PROCESSES** Introduction & Methods Used in Gear Making; Hobbing & Shaping Processes. Gear Finishing Operations: Shaving, Burnishing & Grinding.	**2**

S. No.	**List of Experiments:**	**Number of Hours**
1	Layout making and Job preparation through hacksaw cutting and centering.	**2**
2	Basic understanding of the turning processes on lathe such as tapering, threading, chamfering etc.	**4**
3	Understanding how to perform indexing and gear cutting on a milling machine.	**4**
4	Understanding the Quick return mechanism of a shaper.	**2**
5	Learning the drilling processes and various tools used in it.	**1**
6	Understanding the grinding process and sharpening of tools.	**1**

Course Outcomes:	
1	Choose specific machines for a particular job
2	Understand the basic mechanisms like quick return mechanism in shaper and half lever mechanism in lathe
3	Understand the principles of metal cutting and find out the machining times for a given data.

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Materials and Processes In Manufacturing", John Wiley & Sons, DeGarmo	2011
2	"Machining Technology", PN Rao	2010
3	"Modern Machining Process", P C Pandey & H S Shan, Tata McGraw Hill	2008
4	"Production Technology", PC Sharma, S Chand Publications	2007
5	"Manufacturing Science", Ghosh, A., &Mallik, A.K., East West Press Pvt. Ltd.	1999

Course Name	**:**	**MANUFACTURING PROCESSES-II**
Course Code	**:**	**PR1004**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objective:	
1	The student shall be exposed to the basic manufacturing techniques such as casting, metal forming, welding and powder metallurgy along with some lab exposure
2	At the end of the course the students should be able to apply these concept in controlled lab environment

Total Number of Lectures- 28

S. No.	**Course Content**	**Number of Lectures**
1.	**METALLURGY** Iron Carbon Diagram, Solidification of Pure Metals And Alloys, Nucleation And Growth In Alloys, Solidification Of Actual Castings, Progressive And Directional Solidification. Principles OfPhase Transformations, Phase Rule, Equilibrium Diagrams, Recovery, Recrystallization And Grain Growth.	**6**
2.	**HEAT TREATMENT** Basic Principles Involved In Heat Treatment Of Plain Carbon Steels & Alloy Steels, Principles &Applications Of: Annealing, Normalizing, Hardening, Tempering, Surface Hardening Of Steels, Principles Of Induction & Oxyacetylene Flame Hardening. Procedure For Carburizing, Nitriding& Cyaniding, Harden-Ability: Jominey End Quench Test Method	**6**
3.	**INTRODUCTION TO METAL CASTING** Types Of Pattern, Pattern Allowances, Pattern Design, Recent Development In Pattern Design, Types Of Sand, Properties Of Moulding Sand, Testing Of Sand	**5**
4.	**GATING SYSTEM AND RISER** Gating Systems And Their Characteristics, Various Parts Of Gating System, Various Types Of Gates, Various Types Of Risers, Function Of Riser, Riser Design.	**2**
5.	**MELTING** Various Types Of Melting Furnaces, Selection Of Melting Furnace	**2**
6.	**MOULDING/CASTING PROCESS** Sand Moulding Machine Moulding, Shell Moulding Process, Investment Casting Process, Centrifugal Casting Process.	**2**
7.	**CASTING DEFECTS** Various Casting Defects, Causes And Remedies Of The Casting Defects	**2**
8.	**POWDER METALLURGY** Characteristics Of Metal Powders And Production Methods, Mixing And Blending, Compacting, Sintering And Finishing, Process Principles, Defects And Limitations And Industrial Applications	**3**

S. No.	Lists of Experiments	Number of Hours
1	Practical exercise on preparation of casting through “Furnace Melting”	2
2	Determination of permeability and green strength of moulding sand.	2
3	Determination of clay content in a given sample	2
4	Determination of grain fineness number for a given sand mix	2
5	Exercise on preparing a casting through furnace melting	2
6	Preparation of a sample for viewing and studyingthe micro-structuresof mild steel and cast iron	4

Course Outcome: The students would be able to:	
1	Select an appropriate heat treatment process for a given application.
2	Select an appropriate casting process for a given application.
3	Design a simple pattern for a given casting

Bibliography:

S. No.	Name of Book/Author/ Publisher	Year of Publication
1	“Principle of introduction to physical metallurgy”, Avner, McGraw Hill.	2012
2	“Elements of Metal Casting”, Richard W. Hein, Carl R. Loperand Philip C. Rosenthal, Tata McGraw Hill Education 2008 3	2008
3	“Foundry, forming and Welding”, P.N. Rao: Tata M/C Graw Hill Publication.	2001

Course Name	**:**	**MANUFACTURING PROCESSES –III**
Course Code	**:**	**PR1005**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objective:	
1	At the end of the course, the students should be able to describe various type of forming processes, classify and identify the different welding processes.
2	At the end of the course, the students should be able to apply the concepts of forming and welding during forming and welding experiments.

Total Number of Lectures- 28

S. No.	**Course Content**	**Number of Lectures**
1.	**METAL FORMING** Introduction, Classification, Effect Of Forming Parameters, Hot And Cold Working Processes, True Strain Curves, Determination Of Flow Stress, Tresca and Von Misces Criteria, Metal Forming Lubrication, Lubrication Mechanism, Boundary Mixed And Hydrodynamic Lubrication.	**10**
2.	**ROLLING** Classification of Rolling Processes, Rolling Mills, Products, Variables, Rolling Defects and Controls. Defects & Remedies.	**3**
3.	**DRAWING** Drawing of Rods, Wires, Tubes, Variables in Drawing and Operations, Analysis of Drawing Forces. Defects & Remedies.	**3**
4.	**FORGING** Open and Closed Forging, Hammer, Press and Drop Forging, Analysis of Forging Forces, Sticking and Sliding Friction. Defects & Remedies.	**3**
5.	**EXTRUSION** Classification of Extrusion Processes, Equipment and Variables Used in Extrusion. Defects & Remedies	**3**
6.	**WELDING** Classification Of Welding Processes, Physics Of Arc, Arc Blow, Welding Symbol, Types Of V-I Characteristics, Different Types Of Power Sources, Classification And Selection Of Welding Electrodes, Welding Fluxes,	**6**

S. No.	**Lists of Experiments**	**Number of Hours**
1	Fabrication exercise by using MMA welding machine	**2**
2	Practical exercise on brazing	**2**
3	Practical exercise on MIG/ TIG welding	**2**
4	Practical exercise on SAW	**2**
5	Study of friction welding process	**2**
6	Wire drawing exercise on the draw bench	**2**
7	Practical exercise on ultrasonic welding process	**2**

Course Outcome:	
1	To select and compare the various forming processes.
2	Ability to fabricate simple welding jobs.
3	Select specific welding applications and innovations.

Bibliography:

S. No.	**Name of Book/Author/ Publisher**	**Year of Publication**
1	"A text book of Production Engineering" , PC Sharma Publisher S Chand	2014
2	"Welding Engineering and Technology", RS Parmar, Khanna Publisher	2013
3	"AWS handbooks", 9thEdition, Volume-2	2011

Course Name	**:**	**MACHINE DRAWING AND TOOL DESIGN**
Course Code	**:**	**PR1006**
Credits	**:**	**4**
L T P	**:**	**2-0-4**

Course Objectives:	
1	At the end of the course, the students should be able to describe the terminologies in machine drawing, get exposed to international standards, symbols, requirements, applications of dimensioning, jigs, fixtures.
2	At the end of the course the students should be able to understand jigs, fixtures and their application.
3	At the end of the course, the students should be able to learn and apply above concept via CAD software for industry oriented applications

Total Number of Lectures-28

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION MACHINE DRAWING** Review of ISI Standard SP 46: Types of Lines, Review of Orthographic Projection.	**2**
2.	**SYMBOLS AND REPRESENTATIONS** Representation of Machining Symbols and Welding Symbols and Joints, Types of Rivets & Joints, Types of Bolts, Nuts & Their Locking Devices, Other Fasteners. Shaft Couplings	**2**
3.	**LIMITS AND TOLERANCES** Limits, Fit, Tolerances, Surface Roughness, General Tolerances; Surface Quality Symbols, Terminology and Representation On Drawings, Correlation of Tolerance and Surface Quality with Manufacturing Techniques. Basic Calculations And Their Drawing Representations	**3**
4.	**SCREW THREADS** Different Conventions Used On Technical Drawings, Types Of Threads, Representation Of Screw And Other Threads	**3**
5.	**ASSEMBLY DRAWINGS** Review Of Sheet Preparation, Boundary Lines, Title Block, Bill Of Material, Assembly Drawings Of Various Machine Sub-Assemblies And Assemblies From Detailed Drawings, Sketch Of Actual Machine Component	**4**
6.	**JIGS AND FIXTURE** Dimensioning Principle Of Jigs & Fixture Design, Location Devices, Design Principle Common To Jigs And Fixtures, Difference Between Jigs And Fixtures, Drawing And Design Of Various Clamping Device.	**4**
7.	**DRILLING JIGS** Box Type, Leaf Type, Indexing Type, Trunnion Type. Etc. **FIXTURES** Milling: String Fixtures, Indexing Fixtures & Mill Fixtures Etc. Grinding: For Cylindrical Grinding, Surface Grinding Assembly And Welding Fixtures, Lathe Fixture For Automobile Components And Frames, Machines Etc.	**5**
8.	**ECONOMICS** Economics Of Jigs And Fixtures ,Selection Of Particular Types Of Jigs And Fixture	**2**

9.	**COMPUTER AIDED DESIGN** Basic Assembly Such As Fasteners, Journal Bearings, Crane Hook, Couplings, Giband Cotter Joint, And Knuckle Joint To be Designed in CAD Software	**3**

S. No.	**List of Experiments:** At least 6 of the following experiments have to be performed	**Number of Hours**
1	Fasteners, Journal bearings	**4**
2	Crane Hook, Couplings	**4**
3	Giband Cotter Joint, Knuckle Joint	**4**
4	Drilling jig (Box type, Leaf type, indexing type, trunnion type etc.)	**4**
5	Milling Fixture (String fixture, Indexing fixture and mill fixture etc.	**4**
6	Lathe fixture (to machine a component)	**4**
7	Assembly & welding fixture (for automobile components & frames, machines etc.)	**4**

Course Outcomes:	
1	Draw basic machine elements such as fasteners, bearings, etc.
2	Read and interpret assembly drawings
3	Design a simple jig for a given application
4	Design and draw a simple fixture for a given application

Bibliography:

S. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	"A First Year Engineering Drawing", AC Parkinson, Pitman	2009
2	"Machine Drawing", ND Bhatt, Charotar Publishing House Pvt.t. Ltd.	2008
3	"Tool Design", Donold son, Tata McGraw Hill	2012
4	"Jigs and Fixtures", PH Joshi, Tata McGraw Hill Edition	2010

Course Name	**:**	**PRODUCTION AND OPERATIONS MANAGEMENT**
Course Code	**:**	**PR1007**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:	
1	At the end of the course, the students should be able to describe the concepts of operations and inventory management
2	At the end of the course, the students should be able to provide inputs to use JIT, Lean and such systems to improve the efficiency

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT** History of Production and Operations Management; Definitions of Production Management; Production Process; Production: The Heart of an Organization; Objectives of Production Management Definition of Operations Management: An Outline of Operations Strategy; Factors Affecting Operations Management, Operations Planning and Control	**4**
2.	**PLANT LAYOUT AND MATERIAL HANDLING** Site Selection, Types Of Layout, Factors Affecting Layout, Plant Building, Flexibility And Expandability, Principles Of Material Handling, TypesAnd Selection Of Materials Handling Equipment's.	**4**
3.	**CONCEPT OF FORECASTING** Importance And Objectives Of Forecasting, Principle Of Forecasting, Classification Of Forecasting ; Qualitative And Quantitative Techniques Of Forecasting: Qualitative Techniques, Quantitative Techniques	**5**
4.	**PRODUCT PROCESS, AND SERVICE DESIGN** Product Selection; Definitions Of Product Design And Development: Need For Product Design And Development, Process Planning And Design, Major Factors Affecting Process Design Decisions, Types Of Process Designs, Interrelations Among Product Design, Process Design & Inventory Policy	**4**
5.	**MATERIAL MANAGEMENT** Definition And Scope; Functions; Types Of Materials; Analytical Structure Of Inventory Models; Material Requirement Planning (MRP); Bill Of Material, Master Production Schedule; Purchase Management; Storekeeping And Issue Of Materials; Material Handling; Just In Time (JIT) And Kanban Systems. Lean Manufacturing: Introduction-Definition And Scope-Continuous Vs. Lean Production- Benefits And Methodology-Process Oriented Continuous Improvement Teams.	**8**
6.	**INVENTORY MANAGEMENT** Nature Of Inventories, Opposing Views Of Inventories, Fixed- Order Period And Quantity Systems, Inventory Models, ABC Analysis Inventory Planning,	**6**
7.	**MANUFACTURING OPERATIONS SCHEDULING:** Scheduling Process- Focused Manufacturing, Scheduling For Job Shop, Flexible Manufacturing System And Product Focused Manufacturing, Computerized Scheduling System, Gantt Chart	**6**

8.	**MAINTENANCE MANAGEMENT** Definition And Objective Of Maintenance Management, Planned Production Maintenance, Preventive Maintenance, Machine Reliability, Reliability Centered Maintenance	**5**

Course Outcomes:	
1	Students shall be able to suggest appropriate layout for a given manufacturing/service problem
2	Students shall be able to suggest appropriate Forecasting technique
3	Students shall be able to Identify and apply systems of inventory, lean or JIT principles for a given case study/ system
4	Students shall be able Design an optimal/near optimal schedule for production/ maintenance

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	Buffa, E.S., Sarin, R.K., "Modern Production / Operations Management", John Willey and Sons	2014
2	"Productions and Operations Management", Chase Aquilano& Richard Irwin, McGraw Hill Series	2010
3	"Productions and Operations Management", Adam & Ebert Prentice Hall	2008
4	Production and Operations Management: An Applied Modern Approach" Joseph S.Martinich , Wiley Student Edition	2008

Course Name	**:**	**INDUSTRIAL ENGINEERING -I**
Course Code	**:**	**PR1008**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:	
At the end of the course the students should be able:	
1	To provide basic understanding to the students about the concept and significance of work study and ergonomics
2	To inculcate the skill among the students for analyzing and improving existing methods of working on the shop floor of an organization.
3	To impart through knowledge and skills to students with respect to allowances, rating, calculation of basic and standard time for manual operations in an organization
4	To inculcate analyzing skills among the students with respect to work place design, working postures and lifting tasks.

Total No. of Lectures– 28

S.No.	Course Contents	Number of Lectures
1.	**INTRODUCTION** Definition And Scope OfIndustrial Engineering Role Of An Industrial Engineer In Industry, Functions Of Industrial Engineering Department And Its Organization, Qualities Of An Industrial Engineer	**2**
2.	**PRODUCTIVITY** Concept, Objectives, Factors Affecting Productivity, Productivity Measurement, Causes Of Low Productivity, Tools And Techniques To Improve Productivity, Work Study And Productivity	**4**
3.	**WORK STUDY** Purpose, Scope and Developments, Human Aspects, Techniques Of Work Study And Their Scope **METHOD STUDY** Objectives And Scope, Recording Techniques: Operation Process Charts, Flow Process Charts, Two Hand Process Chart, Activity Chart, Other Charts, Their Analysis, Flow Diagram, String Diagram, Critical Examination Techniques, Development, Installation And Maintenance Of Improved Methods, Micro Motion Study, Therbligs, Motion Analysis, SIMO Charts, Memo-Motion Study, CyclegraphAndChronocycle Graph, Principles Of Motion Economy; Design Of Work Place Layout.	**8**
4.	**WORK MEASUREMENT** Purpose of Work Measurement, The Basic Procedure, The Techniques Of Work Measurements, Work Sampling: Introduction, Basic Concept And Procedure, Time Study: Rating:Introduction, The Quality Worker, The Average Worker, Standard Rating And Standard Performance. Predetermined Time Standards (PTS): Introduction, Definition, Advantages OfPTS System, Criticisms OfPTS System, Different Forms OfPTS System, Use OfPTS System, And Application OfPTS System	**7**

5.	**WORK DESIGN** Concept Of Job Enlargement, Job Enrichment And Job Rotation, Effective Job Design Consideration Technological And Behavioral Factors	**3**
6.	**ERGONOMICS** Introduction To Industrial Ergonomics, Constituents Areas Of Ergonomics, Man-Machine System, Anthropometry And Ergonomics, Etabolism and Organization Of Work, Ergonomic Aspects In Design Of Controls And Displays And Their Layout, Light And Vibration Consideration In Ergonomically Designed System, Working Conditions And Environment, Ergonomics And Safety	**4**

S. No.	**List of Experiments:**	**Number of Hours**
1	Method to improve the assembly and dis-assembly of a Bolt, a nut and three washers /bulb holder	**2**
2	Methods Improvement – Assemblingof pins on a given board	**2**
3	Rating Practice –Walking on level grounds and dividing a pack of cards into four equal piles.	**2**
4	Stop watch time study on drilling machine, lathe machine and CNC machine	**2**
5	Measurement of anthropometrics data and analysis of data	**2**
6	Ergonomic evaluation for any manufacturing processes.	**2**
7	To measure the respiratory parametersof an individual.	**2**

Course Outcomes:	
1	Students will be able to calculate the basic work content of a specific job for employees of an organization; thereby they will be able to calculate the production capacity ofman powerfor an organization.
2	Students will be able to rate a worker engaged on a live job and calculate basic, allowed and standard time for the same.
3	Apply ergonomic concepts in work environment.

Bibliography:

S. No.	**Name of Book / Authors / Publishers**	**Year of Publication**
1	"International Labour organization, Work-study", Oxford and IBH publishing company Pvt. Ltd., N. Delhi.	2010
2	"Motion & Time study: Design and Measurement of Work", Barnes Ralph M., Wiley Text Books.	2001
3	"Introduction to Ergonomics", Bridger, R.S., CRC Press.	2008
4	"Methods Standards & Work Design", Benjamin E NiebelandFreivaldsAndris, Mc Graw Hill.	1997

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**PR1009**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:	
1	At the end of the course, the students should be able to analysing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.
2	At the end of the course, the students should be able use operations research fundamentals and methodology in industries

Total Number of Lectures – 28

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Origin and Development of Operations Research, Scope Of Operations Research (OR), General Methodology Of OR, OR And Managerial Decision Making, OR Applications In Industrial And Non-Industrial Fields. Classification Of Optimization Problems; Optimization Techniques.	**3**
2.	**LINEAR OPTIMIZATION MODELS** Formulation Of Linear Programming Problem, Graphical Solution, Sensitivity Analysis In Graphical Solution, Comparison Of Graphical And Simplex Algorithm, Simplex Algorithm, Computational Procedure In Simplex, Big M Method, Two Phase Method, Degeneracy, Duality And Its Concept, Application Of LP Model To Product Mix And Production Scheduling Problems.	**9**
3.	**THE TRANSPORTATION MODEL** Solution Methods, Balanced and Unbalanced Problems, Vogel's Approximation Method, Degeneracy in Transportation Problems. Assignment Problem, Methods for Solving Assignment Problems. The Traveling Salesman Problem. Numerical On Transportation, Assignment and Traveling Salesman Method. Computer Algorithms For Solution To LP Problems.	**5**
4.	**DYNAMIC PROGRAMMING PROBLEMS** Model Formulation, Computational Procedures, Solution In Different Stages.	**3**
5.	**GAME PROBLEMS** Minimax Criterion And Optimal Strategy; Two Person Zero Sum Game; Games By Simplex Dominance Rules.	**4**
6.	**PERT AND CPM** Network Representation. Critical Path Computations. Construction of The Time Schedule. Linear Programming Formulation of CPM. PERT Calculations.	**4**

Course Outcomes:	
1	Analyse any real life system with limited constraints and depict it in a model form.
2	Convert the industry/ real life problem into a mathematical model using basic software.
3	Apply the PERT/CPM for a constraint based problem of service/ manufacturing
4	Understandand solve variety problems of assignment, transportation, travelling salesmanand sequencing

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"An Introduction to Operations Research", Taha, H.A., 9th Ed., Prentice Hall of India	2011
2	"Operations Research", Panneerselvam R., PHI	2011
3	"Operations Research",P. K. Gupta and D.S. Hira, S. Chand	2008
4	"Principles of Operations Research", Wagner H M, Second Edition, Prentice Hall of India Private Limited, New Delhi.	2003

Course Name	**:**	**COMPUTER INTEGRATED MANUFACTURING & METROLOGY**
Course Code	**:**	**PR1010**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to describe geometric transformations and modelling
2	At the end of the course, the students should be able toidentifying the concepts of process planning, material handling and cellular manufacturing.

Total Number of Lectures – 28

S. No.	Course Content	Number of Lectures
1.	**COMPUTER AIDED DESIGN** The Product Design Process, CAD System Input – Output Devices, Selection Of CAD/CAM Systems	**2**
2.	**COMPUTER GRAPHICS AND TRANSFORMATION** Geometric Transformations, Homogeneous Representation, Composition Of Transformations	**2**
3.	**GEOMETRIC MODELING** Geometric Modelling Approaches, Wireframe Modelling, Surface Modelling, Solid Modelling, Parametric and Variational Design, Rapid Prototyping	**2**
4.	**COMPUTER AIDED ENGINEERING ANALYSIS** Finite Element Modelling, Design Optimization, Commercial Packages To Support Product Modelling And Analysis	**2**
5.	**CELLULAR and FLEXIBLE MANUFACTURING SYSTEMS:** Part Families, Parts Classification and Coding, Production Flow Analysis Cellular Manufacturing, Applications Of Group Technology, Concept Of FMS Its Planning And Applications, Material Handling For FMS, AHVS, Automated Storage System	**3**
6.	**PROCESS PLANNING AND CONCURRENT ENGINEERING** Process Planning, Computer Aided Process Planning, Concurrent Engineering And Design For Manufacturing, Advanced Manufacturing Planning	**2**
7.	**LIMITS, FITS AND TOLERANCES** Concept of Interchangeability, Types of Interchangeability, Need for Standard Systems Of Limits, Fits And Tolerances, BIS; 919; 1963 Standard System, Selection Of Limits And Fits Exercises On Limits, Fits And Tolerances, Design Principles For Limit Gauges. Taylor's Principle, Types of Limit Gauges, Tolerances On Limit Gauges. Need Of Standards, Classification: Primary, Secondary And Tertiary Standards	**4**
8.	**MEASURING AND GAUGING INSTRUMENTS** Design Principles of Measuring Instruments; Kinematics Design, Principle of Alignment. Pivots and Bearings, Sources of Error In Measurement, Calibration Of Measuring Instruments: Mechanical Linear And Angle	**4**

	Measuring Instruments. Vernier Callipers, Micro - Meters, Dial Gauges, Bevel Protectors, Sine Bar Spirit Level, Optical Instruments; Autocollimator, Tool Room Microscope, Length Measuring Machines, Comparators; Magnification Principles, Types Of Comparators, Mechanical, Optical, Pneumatic, Electrical And Electronic Comparators	
9.	**GEOMETRICAL METROLOGY** Concept Of Form Errors, Straightness, Flatness, Roundness, SquarenessAnd Concentricity Errors And Their Measurements, Concept Of Surface Finish And Its Measurement.	**2**
10.	**INSPECTION TECHNOLOGIES** Sources of Error in Measurement, Calibration Of Measuring Instruments: Mechanical Linear And Angle Measuring Instruments. Vernier Callipers, Micro - Meters, Dial Gauges, Bevel Protectors, Sine Bar Spirit Levels, Gauges And Comparators.	**3**
11.	**INSPECTION METHODS** Coordinate Measuring Machines, Surface Measurement, Machine Vision, Other Optical Inspection Methods, Noncontact Non-Optical Inspection Techniques.	**2**

S. No.	**List of Experiments:**	**Number of Hours**
1	Practical on FMS layouts and simulation, AGVs/Robots	**2**
2	Practical on micro-hardness tester	**2**
3	Practical on roughness tester	**2**
4	Practical on CMM-I	**2**
5	Practical on CMM-II	**2**
6	Practical on digital Vernier calliper/digital micrometer	**2**
7	Practical on digital height gauge and optical profile projector	**2**

Course Outcomes:	
1	Identify and differentiate the different components involved in CAD
2	Perform simple geometric transformations
3	Identify the standards used for measuring devices and identification of errors in measurements.

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Systems Approach to Computer Integrated Design and Manufacturing", Nanua Singh, John Wiley Sons	1995
2	"Automation Production Systems and CIM", Groover, Prentice Hall	2007
3	"CAD/CAM; Principles and Applications", P N Rao, Tata McGraw Hill	2004
4	"Text book of Engineering Metrology", I C Gupta, Dhanpat Rai	2010
5	"Metrology Handbook manual" - Mitutoyo, Japan	2015

Course Name	**:**	**INDUSTRIAL ENGINEERING II**
Course Code	**:**	**PR1011**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:	
1	At the end of the course, the students should be able to describe quality management systems, statistical processes and application of reliability engineering
2	At the end of the course, the students should be able to apply the concepts of supply chain and value engineering.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**QUALITY MANAGEMENT** Introduction to the concepts of Quality, Quality control, quality assurance Introduction to Statistical process control and statistical Quality Control, application of statistics in quality control: Statistical Process Control, Acceptance sampling Concept of variation, cause of variation: Common Cause & Special Cause of variation, Natural control limits of process, stable v/s capable process, Impact of variability in competitive environment	**6**
2.	**CONTROL CHARTS FOR VARIABLES** X Bar-R Charts, X Bar-s Charts, Moving Range (MR), Individual Moving Range (IMR) Charts, Exponentially Weighted Moving Average (EWMA). **CONTROL CHART FOR ATTRIBUTES** p- Charts, np-Charts, c-Charts, u-Charts	**6**
3.	**PROCESS CAPABILITY ANALYSIS, PROCESS CAPABILITY INDICES** Cp, Cpk, Cpm Process Performance Analysis From Short Pre- Production; Pp, Ppk Process Capability For Attribute Data; DPU (defects per unit), DPMO (defects per million opportunity, RTY (Rolled throughput yield)	**5**
4.	**ACCEPTANCE SAMPLING PLANS** Single, Double, Multiple and Sequential – For Attributes, Minimum Inspection Per Lot, Formulation Of Inspection Lots And Selection Of Samples. OC curve. Doge-Romig Tables And Deming Kp Rule	**5**
5.	**INTRODUCTION TO RELIABILITY ENGINEERING** Relationship Between Reliability, Maintainability And Availability, Availability – Operational, Inherent And Achieved; MTBF And MTTR	**3**
6.	**FAILURE DISTRIBUTION, RELIABILITY FUNCTION** Mean Time To Failure, Hazard Rate Function, Bathtub Curve, Life Testing And Reliability, Failure Terminated Tests, Time Terminated Tests, Sequential Reliability Testing, Constant Failure Rate Models (Exponential Reliability Function), Weibull Distribution, Normal Distribution, Lognormal Distribution	**6**
7.	**SYSTEM RELIABILITY** Basics Of Redundancy – Standby Redundancy Systems, Use Of Reliability Block Diagrams, System With Components In Series, System With Components In Parallel, Mixed System, K-Out-Of-N Redundancy, Fault Tree Construction And Analysis, Design For Reliability: Basic Parameters,	**5**

	Reliability Allocation, Redundancy, Failure Analysis	
8.	**SUPPLY CHAIN AND LOGISTICS MANAGEMENT** Overview of Supply Chain and Supply Chain Management. Supply Chain Performance and Profitability. Role Of Supply Chain Management And Its Scope And Importance	**3**
9.	**VALUE ENGINEERING** Introduction: History, Development and Scope of Value Management, Value Analysis Vs. Value Engineering Principles Of Costing And Cost Estimation, Benefits. Basic Concepts Of Value Engineering	**3**

Course Outcomes:	
1	Design and apply the control charts/ sampling methods for a given application,
2	Design series, parallel and mixed system for a given system reliability
3	To understandand apply the conceptsof supply chain management and value engineering

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Fundamentals of Quality Control and Improvement", AmitavaMitra, 3rd Edition Wiley and Prentice Hall and Pearson low cost.	2012
2	"Statistical Quality Control", Eugene L. Grant, McGraw-Hill Series in Industrial Engineering and Management	2017
3	"Reliability engineering", L. Shrinath	2005
4	"An Introduction to Reliability and Maintainability Engineering", Charles E.Ebeling, Tata McGraw-Hill	2000
5	"Supply Chain Management: Text and Cases" , Jannat Shah, Pearson Publications	2009
6	"Value engineering Concept , Techniques and Applications", Anil kumarMukhopadhyay Sage publications	2003

Course Name	**:**	**DESIGN OF MACHINE ELEMENT**
Course Code	**:**	**PR1012**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:	
1	At the end of the course the students should be able to describe the basics of machine elements, its design; identify various fasteners, drives
2	At the end of the course, the students should be able to design various drives, springs etc.

Total No. of Lectures - 28

S. No.	**Course Content**	**Number of Lectures**
1.	**FUNDAMENTALS OF DESIGN** Scope and Meaning Of Design With Special Reference To Machine Design. Concept Of Tearing, Bearing, Shearing, Crushing, Bending Etc. Selection of Materials, Behaviour of Materials. Fabrication Characteristics of Materials. Stress Concentration, Factor of Safety Under Different Loading Conditions, Stress Concentration Factors. Design Stress for Variables and Repeated Loads. Endurance Limit, Fits And Tolerance and Finish.	**4**
2.	**FASTNERS** Cotters And Cotters Joints, Pin Fasteners, Knuckle Joints, Welded Joints And Rivet Connection, Eccentrically Loaded	**1**
3.	**DESIGN OF BELT DRIVE** Selection of A Belt Drive, Types Of Belts, Working Stresses In Belts, Coefficient Of Friction Between Belt And Pulley, Belt Joints, Slip & Creep Of The Belt, Length Of An Open Belt Drive, And Length Of A Cross Belt Drive. V-Belt, Types Of V-Belts And Pulleys, Ratio Of Driving Tensions For V-Belt, V-Flat Drives	**4**
4.	**DESIGN OF GEAR DRIVE** Factors Influencing The Choice Of A Gear, Condition For Constant Velocity Ratio Of Gears–Law Of Gearing, Forms Of Teeth, Interference In Involute Gears, Minimum Number Of Teeth To Avoid Interference. Design Considerations For A Gear Drive, Beam Strength Of Gear Teeth, Permissible Working Stress For Gear Teeth, Dynamic Tooth Load, Static Tooth Load, Wear Tooth Load, Causes Of Gear Tooth Failure, Design Procedure For Spur Gears And Helical Gear	**4**
5.	**DESIGN OF SPRINGS** Types Of Springs, Material For Helical Springs, Compression Spring Terminology, End Connections For Tension & Compression Helical Springs, Stresses In Helical Springs Of Circular Wire, Deflection Of Helical Springs Of Circular Wire, Eccentric Loading Of Springs, Buckling Of Compression Springs, Surge In Springs, Energy Stored In Helical Springs Of Circular Wire, Helical Springs Subjected To Fatigue Loading, Springs In Series, Springs In Parallel, Concentric Or Composite Springs, Helical Torsion Springs, Flat Spiral Springs, Leaf Springs, Construction Of Leaf Springs	**4**
6.	**DESIGN OF A SLIDING AND ROLLING TYPE OF BEARINGS** Types of Sliding Contact Bearings, Hydrodynamic Lubricated Bearings,	**4**

	Wedge Film Journal Bearings, Squeeze Film Journal Bearings, Lubricants, Bearing Characteristic Number and Bearing Modulus for Journal Bearings, Critical Pressure of Journal Bearing, Sommerfeld Number. Design Procedure for Journal Bearings, Solid Journal Bearing, Bushed Bearing, Split Bearing or Plummer Block, Design of Bearing Caps and Bolts. Thrust Bearings, Foot-Step or Pivot Bearings, Collar Bearing Types of Rolling Contact Bearings, Radial Ball Bearings, Designation of Ball Bearings, Thrust Ball Bearings. Basic Static Load Rating Of Rolling Contact Bearings, Static Equivalent Load For Rolling Contact Bearings	
7.	**SHAFTS, KEYS AND COUPLINGS** Types of Shafts, Standard Sizes Of Transmission Shafts, Stresses In Shafts, Maximum Permissible Working Stresses For Transmission Shafts, Design Of Shafts, Shafts Subjected To Twisting Moment & Bending Moment, Shafts Subjected To Axial Load In Addition To Combined Torsion And Bending Loads, Design Of Shafts On The Basis Of Rigidity. Types Of Keys, Strength Of A Sunk Key, Effect Of Key Ways, Types Of Shaft Couplings, Design Of Flange Coupling, Flexible Coupling, Bushed In Flexible Coupling, Old Ham Coupling, Universal Coupling	**4**
8.	**MODELING AND SIMULATION** Basics Of Modelling And Simulation, Stress Concentration And Failure Of A Elements Due To Various Loading Conditions In ANSYS/COMSOL or any other software	**3**

S. No.	**Lists of Experiments**	**Number of Hours**
1	To design the belt drive for a given value ofpower	**4**
2	To design the spur gear for a given value of torque	**4**
3	Exercise on springs (helical and leaf spring)	**4**
4	Understanding the process in Design a key	**2**

Course Outcomes:	
1	Classify different machine elements and understand their failure modes
2	Identify and apply the required criterion for designing different machine elements
3	Design some basic machine elements like shafts and bearings

Bibliography:

S. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	"Machine Design", PC Sharma and DK Aggarwal, SK Katariaand Sons,11th edition	2013
2	"Hartman &Maleev's Machine Design", O.P. Groover, CBS	2011
3	"Manual of Machine Design", Frank Castle, Amazon Books	2009
4	"Mechanical Engineering Design", by Shigley JE , McGraw Hill	2017

Course Name	**:**	**ADDITIVE MANUFACTURING**
Course Code	**:**	**PR2001 / PR4001/ PR5101 / PR6002**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to understandthe different additive manufacturing techniquesand their principles.
2	At the end of the course, the students should be able to understandthe challengesin additive manufacturing.
3	At the end of the course, the students should be able to understandand apply the additive manufacturing approach in industries and other applications.

Total Number of lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Classification Of Additive Manufacturing (AM) Processes. AM Based Rapid Prototyping (RP) Systems Like Stereo-Lithography, Fused Deposition Modelling (FDM), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), 3-D Printing, LENS etc.	**10**
2.	**AM IN PRODUCT DESIGN AND DEVELOPMENT** Role Of Additive Manufacturing And Rapid Prototyping In Product Design And Development. Solid Modelling Techniques For Additive Manufacturing With Comparison, Advantages And Disadvantages	**10**
3.	**AM PROCESS CYCLE** Process Planning For Rapid Prototyping, STL File Generation Defects In STL Files And Repairing Algorithms, Slicing And Various Slicing Procedures	**8**
4.	**CHALLENGES IN AM** Accuracy Issues In Additive Manufacturing, Properties of Metallic And Non-Metallic Additive Manufactured Surfaces, Stress Induced In Additive Manufacturing (AM) Processes. Surface Roughness Problem In Rapid Prototyping, Part Deposition Orientation And Issues Like Accuracy, Surface Finish, Build Time, Support Structure, Cost Et	**10**
5.	**RAPID TOOLING** Rapid Tooling Techniques Such As Laminated Metallic Tooling, Direct Metal Laser Sintering, Vacuum Casting Etc.	**4**

Course Outcomes:	
1	Classify different types of additive manufacturing (AM) processes.
2	Understand process cycle of AM processes.
3	Applying the concept of AM for real life problems.

S. No.	**List of Experiments**	**Number of Hours**
1	Learning, design and fabrication of the additive manufacturing process for a given component.	**14**

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Rapid Prototyping: Principles and Applications in Manufacturing" Chua, C.K., Leong, K.F., John Wiley and Sons Inc.	2000
2	"Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" Pham, D.T., Demov, S.S., Springer-Verlag London Limited.	2001
3	"Rapid Prototyping", Gebhardt, A., Hanser Gardner Publications, Inc., Cincinnati	2003

Course Name	**:**	**SUPPLY CHAIN MANAGEMENT**
Course Code	**:**	**PR2002/ PR5001/ PR6001**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The objective of the course is to provide the student's, knowledge of strategic importance of good supply chain design, planning, and operation for industries.
2	To understand how good supply chain management can lead to competitive advantages and understandweaknesses that could hurt the performance of industries.
3	Understand the various Drivers in supply chain performance its practical relevance and understanding the knowledge of various distribution networks along with their applications.

Total Number of lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Understanding Supply Chain, Supply Chain Performance; Supply Chain Drivers And Obstacles.	**4**
2.	**PLANNING DEMANDAND SUPPLY IN A SUPPLY CHAIN** Demand Forecasting in Supply Chain, Aggregate Planning In Supply Chain, Planning Supply And Demand; Managing Predictable Variability, Economic Order Quantity Models, Reorder Point Models, Multi-Echelon Inventory Systems. Managing Uncertainty In A Supply Chain, Determining Optimal Levels Of Product Availability.	**7**
3.	**SUPPLY CHAIN PERFORMANCE** Supply Chain Strategies, Achieving Strategic Fit, Product Life Cycle, The Minimize Local Cost View, The Minimize Functional Cost View, The Maximize Company Profit View, The Maximize Supply Chain Surplus View. **SOURCING DECISIONS IN SUPPLY CHAINS** Role Of Sourcing In Supply Chains, Supplier Assessment, Design Collaboration, Sourcing Planning And Analysis, Market Sourcing Decisions In Practice.	**10**
4.	**NETWORK DESIGN** Factors Influencing Distribution in Network Design, Distribution Networks in Practice, Framework For Network Design Decisions, Models For Facility Location And Capacity Allocation, Making Network Design Decisions In Practice. Global Supply Chain Networks.	**7**
5.	**TRANSPORTATION IN A SUPPLY CHAIN** Facilities Affecting Transportation Decisions, Modes of Transportation and Their Performance Characteristics, Design Options For A Transport Network, Trade-Offs In Transportation Decision, Tailored Transportation, Routing And Scheduling In Transportation, Making Transportation Decisions In Practice.	**7**
6.	**COORDINATION IN A SUPPLY CHAIN** Lack of Supply Chain Coordination And The Bullwhip Effect, Effect Of Lack Of Coordination On Performance, Obstacles To Coordination, Managerial Levers To Achieve Coordination, Achieving Coordination In Practice. Information Technology And Its Use In Supply Chain.	**7**

Course Outcomes:	
1	Students will be able to apply the knowledge of Linear Programming to find optimal solutions of Supply Chain & Logistics related problems.
2	Solve some mathematical models manually as well as using software'sand develop interest for research & higher education.
3	Students will be able to Interpret, apply the concepts of logistics, and supply chain management in improving other functional areas of business organizations.
4	Students will be able to understand different types of distribution networks and design a network for meeting a particular strategy of an organization

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Supply Chain Management – Strategy, Planning andOperation", Sunil Chopra and Peter Meindl, Pearson/PHI, 3rdEdition.	2007
2	"Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies", Levi D. S., Kaminsky P. and Levi E. S., McGraw Hill Inc. New York.	2000
3	"Marketing logistics: A Supply Chain Approach", Kapoor K K, KansalPurva, Pearson Education Asia.	2003
4	"Logistics and Supply Chain Management", Christopher Martin, Pearson Education Asia.	2004

Course Name	**:**	**ADVANCED OPERATIONS RESEARCH**
Course Code	**:**	**PR2003**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The objective of this course is to develop an ability in the students to understandand analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively.
2	Formulate mathematical models for quantitative analysis of managerial problems in industry, develop skills in the use computer tools in solving real problems in industry

Total No. of Lectures– 42

S. No.	Course Contents	No. of Lectures
1	**INTRODUCTION TO ADVANCED OPTIMIZATION TECHNIQUES** Development& scopeof Operations Research, General Methodology ofOR, and Managerial Decision Making, Applications in Industrial and Non-Industrial Fields. Genetic Algorithms (GA), Simulated Annealing, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Neural Network, Separable Programming, Stochastic Programming, Monte Carlo Simulation.	**3**
2	**CLASSIFICATION OF OPTIMIZATION PROBLEMS** Classical Optimization Techniques - Unconstrained Optimization: Optimizing Single Variable Functions, Conditions for Local Minimum andMaximum, Optimizing Multi Variable Functions. Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Lagrange Multipliers Method. Constrained Multivariable Optimization With Inequality Constrained:Kuhn-Tucker Necessary Conditions, Kuhn –Tucker SufficientConditions.	**8**
3	**ADVANCED TOPICS IN LINEAR PROGRAMMING** Introduction and linear Programming, Revised Simplex Algorithm, Simplex Method for Bounded Variables, One Dimensional Cutting Stock Problem, Dantzig-Wolfe Decomposition Algorithm, Dantzig-Wolfe Decomposition Algorithm Primal-Dual Algorithm, Primal-Dual Algorithm, Goal Programming-Formulations, Goal Programming solutions Complexity of Simplex Algorithm. Large-scale Linear Programming	**9**
4	**INTEGER PROGRAMMING** Complexity of Simplex Algorithm, Integer Programming-Formulations, Solving Zero-One Problems, Branch And Bond Algorithm For Integer Programming, Cutting Plane Algorithm, All Integer Primal Algorithm, All Integer Dual Algorithm	**5**
5	**ADVANCED OPTIMIZATION TECHNIQUES** Large-scale Linear Programming, Network Flow Models, Integer Programming Models , Advanced Models and Methods	**5**
6	**NON-LINEAR PROGRAMMING** Direct Search Method, Gradient Method. **EVOLUTIONARY ALGORITHMS** Introduction To Genetic Algorithms, Binary Coded Gas For Constrained Optimization, And Introduction To Real Coded Gas.	**4**

7	**QUEUING THEORY** Queuing Terminologies, Modelling Arrival AndService Processes, Birth-Death Processes, The M/M/1 Model, The M/M/S Model, The M/M/1/K Model, M/M/S/K Model, Finite Source Models	**4**
8	**INVENTORY MODELS** Introduction To Basic Inventory Model, The Basic EOQ Model, The Continuous Rate EOQ Model, Quantitiy Discounts Model, The EOQ Models With Back Orders, Single-Period Decision Models	**4**

Course Outcomes:	
1	Students shall be able to use variables for formulating complex mathematical and real life models in management science, industrial engineering and transportation science.
2	Students will be able to use various software packages such as Lingo, Solver, and TORA for solving linear programming and integer programming models.
3	Understandand apply different algorithms for solving goal or integer programming, nonlinear programming problems
4	Understand genetic algorithms, Binary/Real coded GAs for constrained optimization, and simulated annealing, ant colonies, particle swarm optimization.

Bibliography:

S. No.	**Name of Book / Authors / Publishers**	**Year of Publication**
1	An Introduction to Operations Research", Taha, H.A., 9th Ed., Prentice Hall of India	2011
2	Operations Research, P. K. Gupta and D.S. Hira, S. Chand	2008
3	Introduction to Operations Research, Hillier F. J. and Lieberman G.J., 7th Edition Holden Day Inc.,	2001
4	Principles of Operations Research, Wagner H M, Second Edition, Prentice Hall of India Private Limited, New Delhi.	2003

Course Name	**:**	**KNOWLEDGE BASED SYSTEMS IN ENGINEERING**
Course Code	**:**	**PR2004**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	To develop a systematic approach for design and implementation of engineering systems.
2	To develop basic understanding of machine learning, artificial intelligence and their application.
3	To understand intelligent manufacturing and its application.

Total Number of Lectures: 42

S. No.	**Course contents**	**Number of Lectures**
1.	**KNOWLEDGE BASED SYSTEMS** Knowledge Representation, Knowledge Acquisition And Optimization , Knowledge Based Approaches To Design Mechanical Parts And Mechanisms And Design For Automated Assembly	**8**
2.	**MACHINE LEARNING** Machine Learning Concept, Artificial Neural Networks, Types Of Neural Networks, Applications In Manufacturing, Use Of Fuzzy Logic For Machine Thinking	**10**
3.	**ARTIFICIAL INTELLIGENCE** Basic Concepts Of Artificial Intelligence, System Components, System Architecture, Branches In AI, Human And Machine Intelligence.	**8**
4.	**INTELLIGENT MANUFACTURING** Introduction, Applications In Engineering And Manufacturing, Intelligent Manufacturing, Intelligent System For Design And Equipment Selection	**8**
5.	**KNOWLEDGE BASED GROUP TECHNOLOGY** Group Technology In Automated Manufacturing And Engineering System, Structure Of Knowledge-Based System For Group Technology, Visual Method, Coding Method, Cluster Analysis Method	**8**

Course Outcomes:	
1	Students should be able to evaluate the performance of the manufacturing system.
2	Students should be able to apply the concepts of AI and machine learning for improving the overall effectiveness of the manufacturing system.
3	Students should be able to develop the integration of group technology and knowledge-based system with the design system.

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Artificial Intelligence: Approaches, Tools and Applications", Brent M. Gordon (Editor), Nova Science Publisher, New York	2011
2	"Artificial Intelligence in Manufacturing Research", J. Paulo Davim (Editor), Nova Science Publisher, New York	2010
3	"Intelligent Manufacturing Systems", Andrew Kussiak, Prentice Hall	1990
4	"Introduction to Artificial Neural Systems", Jacek M. Zurada, JAICO Publishing House Ed.	2006

CourseName	**:**	**ADVANCED FOUNDARY TECHNOLOGY**
CourseCode	**:**	**PR2005**
Credits	**:**	**4**
LTP	**:**	**3-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to describe the principles in solidification, designing the casting systems and controlling the defects.
2	The students will be able to learn and perform some practical's based on advanced casting techniques

TotalNumberofLectures–42

S. No.	Course Content	Number of Lectures
1.	**INTRODUCTION** Ferrous And Non-Ferrous Materials And Their Properties, Pattern Allowances, Sand Properties, Testing And Control, Special Sand Additives, Metallurgical Consideration Of Cast Iron, SG Iron, Steel, Aluminum, Mg- Alloys AndTi-Alloys For Casting Process, Progressive And Directional Solidification.	**6**
2.	**PATTERN AND CASTING DESIGN** Pattern Design, Recent Developments In Pattern Design, Materials And Construction; Casting Design Considerations- Review Of Casting Design, Recent Trends.	**6**
3.	**CASTING PROCESSES** Review And Critical Comparison Of Various Established Process, Cold Chamber And Hot Chamber Die Casting, Recent D E.G. Low Pressure And High Pressure Moulding, Full Moulding Process, Hot And Cold Box Moulding, Ceramic Shell Molding, Squeeze And Pressed Casting	**6**
4.	**RISERSAND GATING SYSTEM** Riser Design, Risering Curves, NRL Method Of Riser Design, Feeding Distance, RiseringOf Complex Casting, RiseringOf Alloy Other Than Steel.	**4**
5.	**INTERNAL STRESSES AND SURFACE FINISH** Residual Stresses, Defects And Surface Residual Stresses, Hot Tears And Cracking In Casting, Stress Relief, Defects And Their Causes & Remedies	**4**
6.	**TESTING, INSPECTION AND QUALITY CONTROL** Testing Of Sand, Recent Development E.G. Index, Compatibility, X-Ray Mould Ability & X-Ray Radiography, Magnetic Particle, Dye Penetrant And Ultrasonic Inspection, Use Of Statistical, Quality Control In Foundry.	**4**
7.	**HEAT-TREATMENT OF CASTINGS** Heat Treatment Of Steel, Iron And Stainless Steel Castings	**3**
8.	**FURNACE TECHNOLOGY** Furnaces used in Foundry, Crucible, Hearth, Resistance, Arc and Induction Furnaces; Their Construction, Operation & Applications. Heat Treatment Furnaces and Drying Ovens Used in Foundry. Energy Saving in Melting Practices. Melting Practices For Ferrous And Non-Ferrous Alloys.	**5**
9.	**MECHANIZATION** Foundry Mechanization, Pollution Control In Foundries, Inspection, Repair And Salvage Of Castings, Quality Control In Foundries, Casting Design Consideration, Application Software In Casting	**4**

S. No	List of Experiments	Numberof Hours
1	To understandand perform practical work on 3 in 1 Vacuum Casting process	4
2	To understandand perform practical work Stir Casting process	4
3	To understandand perform practical work in Vacuum Casting process	6

CourseOutcomes:	
1	Design the gating and risering systems for a given illustration/data
2	Understandthedifferentpossibledefectsanditsremediesinmetalcasting
3	Identifymethodsto improvethefoundryperformance

Bibliography

S. No.	NameofBook/Authors/Publisher	Year of Publication
1	"Foundry Technology",Beeley Peter R.,Butterworth–Heinemann.	2010
2	"Principles of Foundry Technology",Jain P.L.,Tata McGraw Hill	2010
3	"Principles of Metal Casting Processes",Heine Loper & Rosenthal, McGraw Hill	2004

CourseName	**:**	**ADVANCED WELDING TECHNOLOGY**
CourseCode	**:**	**PR2006**
Credits	**:**	**4**
LTP	**:**	**3-0-2**

Course Objective:	
1	At the end of the course, the students should be able to describe different welding process, classify them based on applications and identify the testing methods
2	At the end of the course, the students should be able to perform some advanced welding techniques in the respective lab in order to enhance their understanding of basic fundamentals of advanced welding

Total Number of Lectures–42

S. No.	**Course Content**	**Number of Lectures**
1.	**NON FUSION WELDING PROCESSES** Resistance, Friction, Explosive, Ultrasonic Welding: Principle, Method Of Operation, Process Variables And Applications.	**8**
2.	**HEAT FLOW IN WELDING** Calculation Of Peak Temperature; Width Of Heat Affected Zone; Cooling Rate And Solidification Rates; Weld Thermal Cycles; Residual Stresses And Their Measurement; Weld Distortion And Its Prevention.	**6**
3.	**EFFECT OF WELDING PARAMETERS** Effect Of Voltage, Current, Wire Feed Rate, Welding Speed, Polarity On Weld Bead Geometry.	**8**
4.	**AUTOMATIONINWELDING** Semi-Automatic Welding, Automatic Welding, Automated Welding, Remote Welding, Robot Welding, Adaptive Controls.	**8**
5.	**SPECIFIC WELDING APPLICATIONS AND INNOVATIONS** Welding In Wind, Welding At Low Ambient Temperature, Welding In Vacuum, Underwater Welding And Welding In Space, Welding Of Ceramics And Plastics.	**6**
6.	**WELDABILITY** Definition Of Weld-Ability, Methods Weld-Ability Evaluation, Weld-Ability Of Carbon Steel, Stainless, Steel, Cast Iron, And Aluminum, Welding Defects, Brazing, Soldering, Thermal Spraying And Surfacing, Pre-Weld And Post Weld Treatments.	**6**

S. No.	**List of Experiments:**	**Number of hours**
1	Fabrication exercise by using Ultrasonic welding machine	**2**
2	Fabrication exercise by using Wirebutt welding machine	**2**
3	Fabrication exercise by using SAW machine	**2**
4	Analyze the effects of welding parameters on bead geometry of the weld	**4**
5	Analyze the effects of welding parameters on the weld characteristics of spot welding Machine	**2**
6	Study on the friction welding process	**2**

CourseOutcomes:	
1	To select the appropriate welding processes.
2	Analyze the effect of welding conditions on bead geometry.
3	Able to learn the specific welding applications and innovations.

Bibliography:

S. No.	NameofBook/Authors/Publisher	Year ofPublication
1	"Welding Engineering and Technology", RS Parmar, Khanna Publishers	2010
2	"Welding Processes and Technology", RS Parmar, Khanna Publishers	2013
3	"Welding Metallurgy", Kuo, S., John-Wiley & Sons Inc.	2003
4	"Welding Handbook: Metals and their weldability", American Welding Society, Volume 1-5	1982

Course Name	**:**	**INDUSTRIAL TRIBOLOGY**
Course Code	**:**	**PR2007**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objective:	
1	At the end of the course the students should be able to describe the friction, wear and identify the various applications of tribology in industry
2	At the end of the course the students should be able to understand the functions and applications of various lubricants and additive

Total Number of Lectures – 42

S. No.	**Course Content**	**No. of Lectures**
1.	**INTRODUCTION** Introduction To Tribology, History Of Tribology, Interdisciplinary Nature, Economic Benefits, Aspects Of Tribology, Nature Of Surfaces And Their Contact, Physico-Mechanical Properties Of Surface Layer, Geometrical Properties Of Surfaces, Method Of Studying Surface, Contact Of Smooth Surfaces, Contact Of Rough Surfaces	**10**
2.	**FRICTION AND WEAR** Role Of Friction, Laws Of Static Friction, Causes Of Friction; Adhesion, Adhesion Theory, Laws Of Rolling Friction, Friction Of Metals And Nonmetals, Friction Measurement; Wear Definitions, Types Of Wear, Mechanism Of Wear, Factors Affecting Wear Behaviour, Measurement Of Wear, A Brief Introduction Of Wear Test Equipment	**8**
3.	**INDUSTRIAL LUBRICANTS AND THEIR ADDITIVES** Importance Of Lubrication, Boundary Lubrication, Mixed Lubrication, Full Fluid Film Lubrication/ Hydrodynamic, Elasto-hydrodynamic Lubrication, Types & Properties Of Lubricants, Solid Lubricants And Their Functions, Liquid Mineral Lubricants, Synthetic Liquid Lubricants, Greases, Properties Of Liquid & Grease Lubricants; Viscosity, Newtonian & Non-Newtonian Lubricants, Temperature & Pressure Dependence Measurement, Other Properties Of Lubricants & Additives.	**8**
4.	**FLUID FILM LUBRICATION** Fluid Mechanics Concepts, Equation Of Continuity & Motion, Generalized Reynolds Equation With Compressible & Incompressible Lubricants, Hydrodynamic Lubrication, Tower's Experiment, Finite Bearings, Partial Journal Bearings, Solution Or Finite Bearings Using Galerkin Method, Hydrostatic Lubrication: Basic Concepts, Applications, Compensated Thrust And Journal Bearings, Controlling Flow With Restrictors	**8**
5.	**APPLICATION OF TRIBOLOGY** Introduction, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings, Areas OfTribological Application (Space, Bio Tribology, Tribo Electronics)	**8**

Course Outcome:	
1	Describe various aspects of tribology
2	Describe friction, wear and lubrication and their importance in industry
3	Identify the processes related to tribology

Bibliography:

S. No.	Name of Book/Author/ Publisher	Year of Publication
1	"Introduction to Tribology" by Bharat Bhushan, John Wiley & Sons	2013
2	"Tribology: Friction and Wear of Engineering Materials", by Ian Hutchings and Philip Shipway	2017
3	"Engineering Tribology" by A.W Batchelorand G.W Stachowiak	1993

Course Name	**:**	**THEORY OF METAL CUTTING**
Course Code	**:**	**PR2008/ PR5104**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	At the end of the course, the students should be able to describe mechanisms in metal cutting, identify and design the variables, cutting parameters and tools used in the process.
2	At the end of the course, the students should be able to understand the design ofbasic cutting toolsandunderstand the various parameters affecting its life.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**MECHANISM OF CHIP FORMATION** Steady of Deformation, Mechanism of Deformation Slip, Twinning & Dislocation, Types of Chips, Single Hear Plane Model and Zone Theory for Determination of Dynamic Shear Strain. Chip Formation in Drilling, Chip Formation in Milling, Effect of Cutting Variables On Chip Reduction Coefficients. Numerical Problems.	**8**
2.	**MECHANISM OF CUTTING** Force System in Turning, Merchant Circle Diagram, Friction and Shear Force, Shear Stress in Turning, Energy in Cutting Process, Kronenberg Relation And Velocity Relation, Chip Deviation And Other Effects On Cutting Forces. Force System In Drilling, Force System In Milling (Vulf& Simulated Model), Numerical Problems.	**9**
3.	**DETERMINATION OF CUTTING FORCES** Theoretical Determination Of Cutting Forces--Shear Angle Relation (Ernst & Merchant, Kronenberg, Lee & Shaffer), Practical Determination Of Cutting Forces-Design Fundamental Of Tool Force Dynamometers Turning, Drilling, Milling And Grinding Dynamometers (Mainly Strain Gauge Type).Tool Life, Machine-Ability, Metal Cutting Optimization (Gilbert Model), Tool Life Test (Mainly Facing Tool Life Test) Machined Surface Finish --Variables That Effect Surface Finish.	**9**
4.	**TOOL LIFE & MACHINEABILITY** Tool Life, Design Of A Single Point Cutting Tool, Factors Affecting Tool Life, Criteria For Tool Life, Mechanism Of Tool Failure, Machine- Ability And Measurement Of Machine Ability Index.	**8**
5.	**DESIGN OF CUTTING TOOLS** Design of Turning Tool Mainly High Production Tool, Design of Twist Drills, Design of Form Milling Cutters, Designs of Round Internal Broach (Pull Type) Of Thin Strips and Circular Discs. Design of Die-Punch for Press Operations Such as Blanking, Punching and Drawing.	**8**

Course Outcomes:	
1	Understand the mechanism of chip formation
2	Understand the tool failure mechanisms and calculate the tool life for a given condition
3	Able to design a single point cutting tool for a given application

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Fundamentals of Metal Cutting and Machine Tools", B. L. Juneja, Nitin Seth, New Age International.	2014
2	"Principles of Metal Cutting", Gopal Chandra Sen, Amitabha Bhattacharyya, New Central Book Agency	2012
3	"Metal Cutting Principles", M.C.Shaw, MIT	2002
4	"Manufacturing Technology: Vol. 2", PN Rao, McGraw-Hill Education	2006

Course Name	**:**	**NON DESTRUCTIVE TESTING**
Course Code	**:**	**PR2009**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The main objectives of this course is to introduce the concept of non-destructive testing among the students and make them understand various types of non-traditional practices available for manufacturing industry.
2	At the end of the course, the students should be able to understand various parameters involved in non-destructive testing

TotalNumberofLectures– 42

S. No.	**Course Content**	**Number of Lectures**
1.	**RADIOGRAPHY** Principle Of Radiography, Types Of Radiography, Equipment For Neutron Radiography, X-Ray Radiography, Equipment For X-Ray Radiography, Advantages And Applications Of Fluoroscopy And Photo Fluoroscopy	**7**
2.	**ELECTROMAGNETIC METHODS** Principle Of Electromagnetic Testing, Mathematical Analysis, Flaw Detection In Conductors, Various Types' Of Instruments Used And Advantages Of Various Electromagnetic Methods For Crack Detection Etc.	**7**
3.	**ULTRASONIC METHODS** Principle Of Ultrasonic Testing, Generation Of Ultrasonic Waves, Equipment Details For Ultrasonic Checking, Methods Of Wave Propagation, Methods Of Flaw Detection, Various Methods Of Ultrasonic Testing, Advantages Of Ultrasonic Methods For Flaw Detection And Crack Location	**7**
4.	**HOLOGRAPHY** Principle Of Holography, Method Of Holographic Recording, Method Of Holographic Reconstruction, Advantages Of This Technique And Applications Of Holographic Methods For Non-Destructive Testing.	**5**
5.	**LIQUID PENETRANT TESTING** Principle Of Liquid Penetrates Testing, Types Of Dyes And Penetrants Used In This Testing Technique And Application Of Liquids For Detecting Sub-Surface Defects.	**7**
6.	**MAGNETIC PARTICLE TESTING** Principles Of Magnetic Particle Testing, Details Of Equipment Used And Methods Of Crack Detection By Magnetic Particle Testing Hardness Testing: Brinnel, Rockwell, Shore andVicker Hardness Testsandunderstand the theory behind various hardness testing methods.	**9**

CourseOutcomes:	
1	The student shall be able to select an appropriate NDT technique for a given application.
2	The student shall be able to set various process parameters and control the NDT process for the desired output parameters.
3	The student shall be able to detect internal flaws in materials by NDT anddefine preventive measures.

Bibliography:

S. No.	NameofBook/Authors/Publisher	YearofPublication
1	"Handbook on Non-destructive Testing of Concrete", Malhotra, Publisher: CRC Press.	2002
2	"Introduction To Nondestructive Testing: A Training Guide", Mix, Paul E, John Wiley and Sons Ltd.	1999
3	"Non Destructive Testing and Evaluation for Manufacturing and Construction", Henrique L M, Hemisphere Publishers, New York, 2001.	2001
4	"Introduction to Industrial and Systems Engineering", Turner W.C., Prentice Hall,	1992

Course Name	**:**	**MATERIALS CHARACTERIZATION**
Course Code	**:**	**PR2010**
Credits	**:**	**4**
LTP	**:**	**3-0-2**

Course Objectives:	
1	Main objectives of this course is to cover the basic principles and techniques of X-ray diffraction, optical, scanning electron and transmission electron microscopy
2	Understandandget acquainted to the specific instruments and study imaging experiments through videosand practical's.

Total Number of lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Scope And Methods Used For Materials Characterization	**4**
2.	**FUNDAMENTALS OF OPTICS** Optical Microscopy Techniques Including Polarized Light and Phase Contrast. Quantitative Metallography and Its Applications. Sample Preparation and Applications of Optical Microscopes Transmission Electron Microscopy: Description of TEM. Formation of Images and Selected Area Diffraction Patterns. Interpretation of Electron Diffraction Patterns. Specimen Preparation Techniques.	**12**
3.	**SCANNING ELECTRON MICROSCOPY** Introduction to Scanning Electron Microscopy (SEM). Description Of SEM. Instrumental Details And Image Formation Of SEM. Image Formation Methods In SEM. Scanning Probe Microscopy: STM And AFM.	**8**
4.	**ANALYTICAL ELECTRON MICROSCOPY** EDS and WDSand EELS. Electron Probe Microanalysis (EPMA)	**6**
5.	**AUGER ELECTRON SPECTROSCOPY** Electron Spectroscopy for Chemical Analysis (ESCA). X-Ray Fluorescence Analysis. SIMS. XPS.UV-Visible and IR Spectroscopy Corrosion Behavior of Materials and Corrosion Testing Techniques. Fundamentals Of X-Ray Scattering, Crystallite Size, Effect Of Strain On The Intensity, Quantitative Analysis, Residual Stress Analysis	**12**

S. No.	**List of Experiments**	**Number of Hours**
1	To Perform Micro Hardness Test for a given specimen	**4**
2	Observation of microstructure throughoptical microscope	**3**
3	To Perform Brinell Hardness Test on a given specimen	**4**
4	To measure and analysis the surface roughness for a given specimen.	**3**

Course Outcomes:	
1	The student shall be able to understand the scope and methods used in characterization
2	The student shall be able to understand the fundamentals of optics and its application in characterization
3	The student shall be able to understand the concept of SEM, TEMand XRD
4	The student shall be able to prepare samples for characterization.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", Yang Leng, John Wiley & Sons (Asia) Pte Ltd	2013
2	"An Introduction to Materials Characterization", P. R. Khangaonkar, Penram International Publishing (India) Pvt. Ltd,	2010
3	"Scanning Electron Microscopy and X-Ray Microanalysis", Joseph I Goldstein, Dale E Newbury, Patrick Echlin and David C Joy, 3rd Edition	2005

Course Name	**:**	**DESIGN AND MANUFACTURING OF COMPOSITES**
Course Code	**:**	**PR2011**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objective:	
1	At the end of the course, students should be able to describe about the composites design and processing techniques.
2	At the end of the course, students should be able to understand various failure mechanisms in composites

Total Number of Lectures- 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Introduction To Composites, Classifying Composite Materials, Commonly Used Reinforcements And Matrix Constituents, Composite Construction, Interface, Effect Of Interfacial Properties On Composite, Properties Of Unidirectional Long Fiber Composites, Short Fiber Composites	**9**
2.	**STRESS STRAIN RELATIONS** Concepts In Solid Mechanics, Hooke's Law For Orthotropic And Anisotropic Materials, Linear Elasticity For Anisotropic Materials, Rotations Of Stresses, Strains, Residual Stresses.	**7**
3.	**ANALYSIS OF LAMINATED COMPOSITES** Governing Equations for Anisotropic and Orthotropic Plates. Angle-Ply and Cross Ply Laminates. Static, Dynamic And Stability Analysis For Simpler Cases Of Composite Plates, Inter-laminar Stresses	**8**
4.	**FAILURE AND FRACTURE OF COMPOSITES** Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics Of Composites, Sandwich Construction.	**6**
5.	**APPLICATIONS AND DESIGN** Metal And Ceramic Matrix Composites, Applications Of Composites, Composite Joints, Design With Composites, Review, Environmental Issues	**5**
6.	**MANUFACTURING PROCESSES FOR COMPOSITE FABRICATION** Processing Of PMC's, Structure And Properties Of PMC, Processing Techniques Of MMC's, Properties of MMC's, Processing of CMC's, Properties of CMC's	**7**

Course Outcome:	
1	Describe the composite materials, their types and properties.
2	Describe the mechanics of composite materials.
3	Understandand describe the manufacturing processes of composites.

Bibliography:

S. No.	Name of Book/Author/ Publisher	Year of Publication
1	"Engineering Mechanics of Composite Materials", Daniel andIshai, Oxford University Press,	2005
2	"Mechanics of composite materials", Jones R.M., McGraw-Hill, Kogakusha Ltd., Tokyo	1975
3	"Analysis and Performance of fiber composites", Agarwal.B.D. andBroutman.L.J., John-Wiley and Sons	1980
4	"Composite Material- Science and Engineering", K. K. Chawla, Springer	2011

Course Name	**:**	**MACHINE TOOL DESIGN**
Course Code	**:**	**PR2012**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1.	To understand the concept of designing &selection of speed drives and feed drives for designing the machine tools.
2.	To understand concept of designing the various structural elements of a machine tool.

Total Number of Lectures: 42

S. No.	**Course contents**	**Number of Lectures**
1.	**INTRODUCTION** Classification Of Machine Tools, Working And Auxiliary Motions In Machine Tools, Parameters Defining Working Motions Of A Machine Tool, General Requirements Of Machine Tool Design.	**5**
2.	**MACHINE TOOL DRIVES** Selection of Electrical Motor, Stepped and Step-Less Output, Upper and Lower Limits of Machine Tools, Layouts of Intermediate Spindle Speeds, Selection of Values of Common Ratio, Speed and Feed Gear Box Design, Gearboxes with Clutched Drives, Feed in Reciprocating Machines, Feed in Drilling Machines, Feed in Milling Machines, Feed in Lathe, Cutting Screw Threads, Double-Bound Gears, Mechanical Drives for Reciprocation. Step-Less Drives, Mechanical, Hydraulic, Electrical Step-Less Drives.	**12**
3.	**STRENGTH AND RIGIDITY OF MACHINE TOOL STRUCTURES** Design Criteria For Machine Tool Structures, Static And Overall Compliance Of Machine Tool, Design Of Lathe Beds, Analysis And Design Of Tailstock Assembly.	**10**
4.	**ANALYSIS OF GUIDEWAYS AND POWER SCREWS** Design Of Slide-Ways For Wear Resistance, Design Of Slide-Ways For Stiffness, Guideways Operating Under Liquid Friction Conditions, Design Of Power Screws.	**8**
5.	**ANALYSIS OF SPINDLES AND SPINDLE SUPPORTS** Functions Of Spindle Unit And Requirements, Design Calculations Of Spindles, Sliding Bearings, Hydrodynamic And Hydrostatic Journal Bearings.	**7**

Course Outcomes	
1	Students should be able to design a simple gearbox for a given machine tool application.
2	Students should be able to understandanddesign some machine tool structures like bed, column, and work holding devices.
3	Students should be able to understandanddesign the guide-ways, spindles and spindle supports.

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Principles of Machine Tools", G C Sen, A Bhattacharyya, Calcutta: New Central Book Agency	2015
2	"Machine Tool Design and Numerical Control", N K Mehta, Tata McGraw-Hill,	2017
3	"Machine Tool Design Handbook", N/A Central Machine Tool Institute, McGraw-Hill Education	2005
4	"Machine Tool Design", N Acherken, Vol. I-IV, University Press of the Pacific	2017

Course Name	**:**	**ADVANCED MANUFACTURING PROCESSES**
Course Code	**:**	**PR2013/ PR5103/ PR6004**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to describe different non-traditional manufacturing methods available and which can be used to enhance the manufacturability.
2	At the end of the course, the students should be able understandand apply concepts of advanced manufacturing processes in industries.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Evolution, Need, Types, Classification and Comparison Between Conventional and Advanced (Modern) Manufacturing Processes (AMP).	**2**
2.	**MECHANICAL PROCESSES** Ultrasonic Machining (USM), Rotary Ultra Sonic Machining (RUM), AJM, WJM,AWJM Processes - Process Principle And Mechanism Of Material Removal; Process Parameters; Process Capabilities; Applications; Operational Characteristics; Advantages And Limitations.	**4**
3.	**CHEMICAL TYPE AMPS** Process Principle And Details Of Chemical Machining (CHM), Photo-Chemical Machining (PCM), And Bio-Chemical Machining (BCM) Processes; Advantages, Applications And Limitations.	**4**
4.	**ELECTRO CHEMICAL TYPE AMPS** ECM - Process Principle; Mechanism Of Material Removal; Process Parameters; Process Capabilities; Applications And Limitations	**4**
5.	**THERMAL TYPE AMPS** EDM, Wire Electro Discharge Machining (WEDM), LBM, EBM, IBM, PAM Processes – Process Principle And Mechanisms Of Material Removal; Accuracy, Surface Finish, Heat Affected Zones; Machine Tool Selection; Process Parameters And Characteristics; Process Capabilities; Applications And Limitations.	**8**
6.	**ADVANCED FINE FINISHING PROCESS** Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magneto Rheological Abrasive Finishing (MRAF) - Process Principle; Process Equipment; Process Parameters; Process Capabilities; Applications; Limitations.	**6**
7.	**DERIVED AND HYBRID PROCESSES** Electro Stream Drilling (ESD), Shaped Tube Electro Machining (STEM), Electro Chemical Honing (ECH), Electro Chemical Deburring (ECDE), Electro Chemical Discharge Machining (ECDM) - Process Parameters; Process	**8**

	Capabilities; Applications; Limitations, Introduction To Form Machining And Newer Processes.	
8.	**RAPID PROTYPING (RP)** Introduction To RP Techniques And Materials, Stereo-lithography, Selective Laser Sintering, Fused Deposition Modelling, Three-Dimensional Printing, Laminated Object Manufacturing, Rapid Tooling, Rapid Manufacturing, Advantages, Applications And Applications Of RP.	**6**

S. No.	**List of Experiments**	**Number of Hours**
1	Study and perform practical on hydro-forming	**2**
2	Study and perform a simple experimenton EDM process.	**3**
3	Study and perform an experiment on hybrid ECM/ ECDM process	**3**
4	Study and practical exposure to AFM/ LBM techniques.	**3**
5	Study and practical exposure to Rapid Prototyping technique.	**3**

Course Outcomes:	
1	Identify, classify and differentiate between the various available techniques.
2	Apply and choose a particular advanced manufacturing technique for a given problem

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Modern Machining Process" Pandey And Shahn, TATA McGraw Hill	2010
2	"Advanced Machining Processes", Vijay K. Jain, Allied Publishers Limited	2005
3	"New Technology" **A** Bhattacharaya, Institution of Engineers, India	2000
4	"AdvancedMachining Processes", Hassan El Hofy, 1st edition, McGraw-Hill Education;	2005

Course Name	**:**	**THERMAL ENGINEERING**
Course Code	**:**	**PR2014**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objective:	
1	At the end of the course, the students should be able to be familiarize with the fundamental of thermodynamics and heat transfer.
2	At the end of the course, the students should be able to understand various gas power cycles

Total Number of Lectures-42

S. No.	Course Content	Number of Lectures
1.	**BASIC CONCEPTS** Macroscopic and Microscopic Approach, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Thermodynamic Equilibrium, State, Path, Process, cycle, Quasi-static Process, Reversible and Irreversible Process, Working Substance. Thermodynamic Properties like Pressure, Volume and Temperature, Zeroth Law of Thermodynamics. Temperature Scales, Concept of Heat and work in Thermodynamics.	**5**
2.	**FIRST LAW OF THERMODYNAMICS** Joule S Paddle Wheel Experiment; Mechanical Equivalent of Heat, First Law for A Closed System Undergoing a Cycle, First Law for A Closed System Undergoing a Change of State. Different Forms Of Stored Energy, Enthalpy, Energy Of An Isolated System, Perpetual Motion Machine Of First Kind.	**4**
3.	**FIRST LAW APPLIED TO FLOW PROCESSES** Flow Process And Control Volume, Flow Work, Steady And Unsteady Flow Process, Steady Flow Energy Equation, Engineering Applications Of Steady Flow Energy Equation, Throttling Process, Flow Work And Non Flow Work, Variable Flow Processes, Limitation Of First Law.	**4**
4.	**SECOND LAW OF THERMODYNAMICS** Qualitative Difference Between Heat And Work, Thermal Reservoir, Statements Of 2^{nd} Law By Max. Planck AndClaussius, Equivalence Between Two Statements, Energy Analysis Of Heat Engine, Refrigerator And Heat Pump Reversibility And Irreversibility, Causes Of Irreversibility Carnot Theorem, Carnot Cycle, Absolute Thermodynamic Temperature, Scale, Efficiency Of The Reversible Heat Engine, Equality Of Ideal Gas Temperature And Kelvin Temperature.	**6**
5.	**ENTROPY** Classius Theorem, Classius Inequality and Concept of Entropy, Entropy Change In An Irreversible Process, Application Of Entropy Principle, Entropy Transfer With Heat Flow, Entropy Generation In Closed And Open System, Thermodynamics Equations Relating Properties Of System, Reversible Adiabatic Work In A Steady Flow System. Entropy And Direction, Entropy And Disorder.	**6**
6.	**GAS POWER CYCLES** Air Standard Efficiency, Mean Effective Pressure, Otto, Diesel, Dual, Brayton, StirlingAnd Ericson Cycle, Comparison Of Cycles.	**6**
7.	**REFRIGERATION AND AIR CONDITIONING** Working of Simple Vapour Compression Cycle, Representation of Various Process On pH Diagram, Air Conditioning Principle, Humidity, Relative	**6**

	Humidity, Representation of Various Air Conditioning Processes On Psychrometric Charts.	
8.	**HEAT TRANSFER** Introduction To Different Modes, Principles Of Conduction Convection And Radiation And Basic Laws	**5**

Course Outcome:	
1	A fundamental understanding of laws of thermodynamics and application to wide range of systems.
2	Familiarity with efficiencies of heat engines and other engineering devicesand its applications.

Bibliography:

S. No.	**Name of Book/Author/ Publisher**	**Year of Publication**
1	"Thermodynamics:**:** An Engineering Approach", Yunus A. Cengel, Michael A. Boles,Mc-Graw-Hill Education	2014
2	"Engineering Thermodynamics", P.K. Nag, Tata McGraw-Hill Education	2013
3	"Engineering Thermodynamics", Gordon Rogers & Yon Machew	2006
4	"Thermodynamics", YunusCengeland Mike Boles	2006

Course Name	**:**	**MODELING AND SIMULATION**
Course Code	**:**	**PR2015**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	To understand the concept of modeling and simulation of a manufacturing system and process.
2	Student will be able to apply the concepts and fundamentals of this course to perform simulations of given problems.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of lectures**
1.	**INTRODUCTION TO MODELING** Concept of system, continuous and discrete systems, types of models, steps in simulation study. Basic Simulation Modeling Fundamental concepts of System Simulation: Discrete event simulation	**8**
2.	**BASIC CONCEPTS FROM PROBABILITY AND STATISTICS** Random Variables, Correlation, Estimation, Probability Distributions, Selection Of Appropriate Probability Distributions Parameterization Of Continuous Distributions And Discrete Distributions Empirical Distributions	**8**
3.	**GENERATING RANDOM VARIETIES GENERATION AND TESTING OF RANDOM NUMBERS** Random Vectors, Correlated Random Varieties and Stochastic Processes. Input Modeling; Hypothesizing Families of Distributions, Confidence Intervals Estimation of Parameters, Testing Goodness of Fit.	**8**
4.	**SIMULATION** Building Monte Carlo / Discrete Event Simulation Models of Various Processes and Systems. Use Languages Such As Python/R/C++ With Case Studies	**6**
5.	**SIMULATION OUTPUT DATA ANALYSIS FOR A SINGLE SYSTEM** Variance reduction techniques. Experimental design, sensitivity analysis and simulation-based optimization.	**6**
6.	**SIMULATION OF MANUFACTURING SYSTEMS** Introduction, Objectives of Simulation in Manufacturing, Simulation Software in Manufacturing Applications. Simulation Case Study In Primary And Secondary Manufacturing	**6**

Course Outcomes:	
1	Student should be able to know model a given problem of manufacturing and industrial engineering.
2	Student should be able to understand the concept of simulation in manufacturing.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Simulation Modeling & Analysis", Averill M. Law and W David Kelton McGraw Hill	1991
2	"Modeling and Simulation for Mechanical Engineers",Kishore V. Pochiraju, Wiley–Blackwell	2021
3	"Manufacturing Systems Modeling and Analysis", Guy L Curry and Richard M Feldman, Springer	2008

Course Name	**:**	**DATA MINING AND BIG DATA**
Course Code	**:**	**PR2016**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1	To make the students understand the fundamental concepts of big data and analytics, about the various applications of AI, and various characteristics of Intelligent agents
2	It will help them to identify and successfully apply appropriate techniques and tools to solve big data problems.

Total Number of Lectures: 42

S. No.	**Course Contents**	**Number of Lectures**
1.	**EVOLUTION OF BIG DATA** Best Practices For Big Data Analytics, Big Data Characteristics, The Promotion Of The Value Of Big Data , Big Data Use Cases- Characteristics Of Big Data Applications, Perception And Quantification Of Value, Understanding Big Data Storage, A General Overview Of High-Performance Architecture, HDFS, Map Reduce And YARN, Map Reduce Programming Model.	**14**
2.	**INTRODUCTION TO DATA MINING SYSTEMS** Knowledge Discovery Process, Data Mining Techniques, Issues, Applications, Data Objects And Attribute Types, Statistical Description of Data, Data Pre-Processing, Cleaning, Integration, Reduction, Transformation And Discretization, Data Visualization, Data Similarity And Dissimilarity Measures.	**14**
3.	**ARTIFICIAL INTELLIGENCE** Definition, Components, Scope, And Application Areas; Turing's Test; Review Of AI Success And Failure, Expert System, Features Of An Expert System, Heuristic And Algorithm, Human Expertise Vs. Artificial Expertise, Knowledge Representation: Rule-Based Methods Frame Based Methods, Tasks And Stages of Expert System Development And Difficulties In Developing An Expert System.	**14**

S. No.	**List of Experiments**	**Number of Hours**
1	Identify appropriate AI methods to solve a given problem.	**7**
2	Design efficient algorithms for mining the data from large volumes.	**7**

Course Outcomes:	
1	To know the fundamental concepts of big data and analytics
2	To know about the various applications of AI
3	Apply the Big Data statistics to a given data set.

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Data Mining Concepts and Techniques", Jiawei Han andMicheline Amber, Third Edition, Elsevier.	2012
2	"Mining of Massive Datasets", AnandRajaramanand Jeffrey David Ullman, Cambridge University Press.	2012
3	"Artificial Intelligence: A Modern Approachǁ", S. Russell and P. Norvig, Prentice Hall, Third Edition.	2009
4	"Analytics in Practice", SoumendraMohanty, Tata McGraw Hill Education	2011

Course Name	**:**	**FINITE ELEMENT METHODS**
Course Code	**:**	**PR2017/ PR4004/ PR6006**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1.	To understand the concept of designing & development of products.
2.	To understand modelling & analysis of a system using finite element analysis.

Total Number of Lectures: 42

S. No.	Course contents	Number of Lectures
1.	**INTRODUCTION TO FEM** The Finite Element Method, Elements And Nodes, Modeling The Problem And Checking Results, Discretization And Other Approximations, Elementary Matrix Algebra.	**5**
2.	**FUNDAMENTAL CONCEPTS** Stresses and Equilibrium, Boundary Conditions, Strain-Displacement Relations, Stress-Strain Relations, Potential Energy and Equilibrium, Rayeigh-Ritz Method.	**6**
3.	**ONE-DIMENSIONAL ANALYSIS** Basis Steps, Discretization, Element Equations, Linear And Quadratic Shape Functions, Assembly, Boundary Conditions, Potential-Energy Approach, Finite Element Equations, Elimination Approach, Penalty Approach, Quadratic Shape Functions	**11**
4.	**TRUSSES** Introduction, Plane Trusses, Local And Global Coordinate Systems, Element Stiffness Matrix, Stress Calculations, Three-Dimensional Trusses	**7**
5.	**TWO-DIMENSIONAL ANALYSIS** Finite Element Modeling, Constant Strain Triangle, Isoperimetric Representation, Potential Energy Approach, Stress Calculations, Four-Node Quadrilateral, Shape Function, Element Stiffness Matrix, Element Force Vectors, Higher Order Elements, Six Node Triangle, Nine Node Quadrilateral, Master Elements, Numerical Problems	**11**
6.	**INTRODUCTION TO 3-D ANALYSIS** Applications and Case Studies	**2**

Tutorial work:

S. No.	Contents	Number of Hours
1	Problems solving on Rayleigh-ritz method	**2**
2	Problems solving on Potential energy method	**2**
3	One-dimensional problems solving and verifying the results using MATLAB program	**2**
4	Truss problems solving and verifying the results using MATLAB program	**2**

5	Two-dimensional problems solving and verifying the results using MATLAB program	**3**
6	To perform the structural static analysis of a corner Bracket and Beams on FEM package.	**3**

Course Outcomes:	
1	Students should be able to solve problems using finite element analysis.
2	Students should be able to carry out structural and thermal analysis.
3	Students should be able to carry out finite element analysis on somegiven consumer products.

Bibliography:

S. No.	**Name of Book / Authors / Publishers**	**Year of Publication**
1	"Finite Elements in Engineering", Chandrupatla&Belegundu, Prentice Hall of India Pvt. Ltd.	2012
2	"The Finite Element Method for Engineers", Huebner K.H., Dewhirst, D. L., Smith, D. E., andByrom, T. G.,4th Ed., John Wiley and Sons	2001
3	"The Finite Element Method in Engineering", Rao, S. S., 4th Ed., Elsevier Science	2005
4	"An Introduction to Finite Element Methods", Reddy, J.N., 3rd Ed., Tata McGraw-Hill	2005
5	"A First Course in Finite Elements", Fish, J., andBelytschko, T., 1st Ed., John Wiley and Sons,	2007

Course Name	**:**	**SMART MATERIALS**
Course Code	**:**	**PR2018**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The students will be able to study and understand the basic of smart materials and their classifications in depth.
2	At the end of the course, the students should be able to understand the significance and applications of smarts materials.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lecture**
1.	**INTELLIGENT MATERIALS** Primitive Functions Of Intelligent Materials; Intelligence Inherent In Materials;Materials Intelligently Harmonizing With Humanity; Intelligent Biological Materials.	**6**
2.	**SMART MATERIALS AND STRUCTURAL SYSTEMS** Actuator Materials; Sensing Technologies; Micro-sensors; Intelligent Systems; Hybrid Smart Materials; Passive Sensory Smart Structures; Reactive Actuator-Based Smart Structures; Active Sensing And Reactive Smart Structures; Smart Skins.	**6**
3.	**ELECTRO–RHEOLOGICAL FLUIDS** Suspensions And Electro, Reheological Fluids; The Electro- Rheological Phenomenon; Charge Migration Mechanism For The Dispersed Phase; Electro Rehological Fluid Actuators.	**6**
4.	**PIEZOELECTRIC MATERIALS** Background; Piezoelectricity; Industrial Piezoelectric Materials; Smart Materials Featuring Piezoelectric Elements.	**6**
5.	**SHAPE MEMORY MATERIALS** Background On Shape Memory Alloys; Applications Of Shape Memory Alloys; Continuum Applications: Structures And Machine Systems; Discrete Applications; Impediments To Applications Of Shape Memory Alloys; Shape Memory Plastics.	**6**
6.	**FIBER OPTICS** Overview; Light Propagation In An Optical Fiber; Embedding Optical Fibers In Fibrous Polymeric Thermosets; Fiberoptic Strain Sensors.	**4**
7.	**THE PIEZOELECTRIC VIBRATIONS ABSORBER SYSTEMS** Introduction; The Single Mode Absorber, Theory, Design Solution, Extension Including Viscous Modal Damping, The Electromechanical Coupling Coefficient, Inductance, Experimental Results; The Multimode Absorber, Derivation Of Transfer Function, Design Solution, Self-Tuning Absorber, Performance Function, Control Scheme.	**8**

Course Outcomes:	
1	Understand basic of smart materials
2	Understand the various types of smart materials and physics behind them
3	Understand the applications of smart materials in industries, structures, biomaterials.

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Smart Materials and structures", Gandhi, M. V. and Thompson, B. S., Chapman& Hall.,	1992
2	"Smart Material structures: Modeling, Estimation and Control", Banks, H. T., Smith, R. C. andQang, Y. W., John Wiley & Sons.	1996
3	"Fundamentals of Smart Materials", P C Pandey & H S Shan, Mohsen Shahinpoor, Royal Society of Chemistry	2020
4	"Functional and Smart Materials", Chander Prakash, Sunpreet Singh, J. Paulo Davim, CRC Press	2020

Course Name	**:**	**MAINTENANCE MANAGEMENT**
Course Code	**:**	**PR2019**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	To acquaint the students with different types of maintenance systems
2	To understand the concept of reliability and replacement decisions in maintenance.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Importance of Maintenance, Objectives, Functions, Responsibilities and Organization Structure of the Maintenance Engineering Department. Classification and Types of Maintenance Activities.	**6**
2.	**MAINTENANCE POLICIES AND PLANNING** Maintenance Strategies, Advantages and Disadvantages of Each Strategy. Planned Maintenance Process, Advantages of Planned Maintenance, Scientific Maintenance and Safety in Maintenance.	**6**
3.	**SYSTEM RELIABILITY** Quantitative Estimation of Reliability; Economies of Introducing a Standby Unit into The Production System. Optimum Design Configuration of a Series, Parallel System Breakdown Time Distribution.	**6**
4.	**MAINTENANCE ACTIVITIES** Optimum Overhaul/Repair or Replacement Policies for Equipment Subject to Breakdown. Budgeting and Control, Production Maintenance Integration.	**6**
5.	**REPLACEMENT DECISIONS** Economic Models, Block Replacement Policy, Age Replacement Policy; Replacement Policy to Minimize Downtimes, Economics of Preventive Maintenance & Case Studies.	**6**
6.	**MAINTAINABILITY AND AVAILABILITY** Economics of Maintainability and Reliability, Maintainability Increment, Equipment and Mission Availability.	**6**
7.	**MAINTENANCE ORGANIZATION** Computer applications in maintenance management, Automatic chalk-out equipment kits, capabilities and limitations, Management Information systems for Maintenance.	**6**

Course Outcomes:	
1	Students would be able to classify different maintenance activities.
2	Select a particular maintenance plan for a given system.
3	Able to decide and evaluate on the replacement of equipment

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Engineering Maintenance: A modern Approach, 1st Edition, CRC.	2002
2	"Maintenance Planning and Control Butterworth Heinemann Ltd, London	1983
3	"Principles of Planned Maintenance", McGraw Hill Inc. New York, Tata McGraw Hill	1983

Course Name	**:**	**OPTIMIZATION TECHNIQUES IN MANUFACTURING**
Course Code	**:**	**PR2020**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	To make the students understand the need of Optimization Techniques and develop the ability to form mathematical model of optimization problems.
2	To make the students able to identify and solve linear and non-linear models of optimization problems.

Total Number of Lectures – 42

S. No.	Course Contents	Number of Lectures
1.	**OPTIMIZATION** Maximum And Minimum Conditions, Optimization Parameters, Levels Of Optimization, Mathematical Representation Of Problem, Optimization Procedures Including Introduction To Some Non-Traditional Methods	**8**
2.	**UNCONSTRAINED OPTIMIZATION TECHNIQUES** Introduction To Optimum Design - General Principles Of Optimization – Problem Formulation & Their Classifications - Single Variable And Multivariable Optimization, Techniques Of Unconstrained Minimization – Golden Section, Random, Pattern And Gradient Search Methods – Interpolation Methods.	**10**
3.	**CONSTRAINED OPTIMIZATION TECHNIQUES** Optimization With Equality And Inequality Constraints - Direct Met	**10**
4.	**INTRODUCTION TO ADVANCED OPTIMIZATION TECHNIQUES** Multi Stage Optimization, Dynamic Programming; Stochastic Programming; Multi Objective Optimization, Genetic Algorithms And Simulated Annealing Techniques; Neural Network & Fuzzy Logic Principles In Optimization.	**10**
5.	**PRACTICAL APPLICATIONS OF OPTIMIZATION** Illustration On Engineering Problems With Single And Multiple Objectives.	**4**

Course Outcomes:	
1	The students are able to form mathematical model of optimization problems.
2	The students are able to distinguish between linear and nonlinear models.
3	The students are able to solve simple problems using Mathematica/ MATLAB

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Practical Genetic Algorithms", Haupt, R. L. andHaupt, S.E., John Wiley & Sons	1998
2	"Genetic Algorithm in Search, Optimization and Machine Learning", Goldberg, D.E., Addison Wesley.	1989
3	Kalyanmoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 2004.	2012

Course Name	**:**	**DESIGN FOR MANUFACTURING**
Course Code	**:**	**PR2021**
Credits	**:**	**4**
LTP	**:**	**3-1-0**

Course Objectives:	
1	Understand modern manufacturing operations, including their capabilities, limitations, and how to design for lowest cost.
2	To make the students understand various approaches and processes in assembly design and automation

Total Number of lectures: 42

S. No.	Course Content	Number of Lectures
1.	**DFMN APPROACH AND PROCESS** Methodologies and Tools, Design Axioms, Design for Assembly And Evaluation, Minimum Part Assessment Taquchi Method, Robustness Assessment, Manufacturing Process Rules, Designer's Tool Kit, Computer Aided Group Process Rules, Designer's Tool Kit. Computer Aided Group Technology, Failure Mode Effective Analysis, Value Analysis. Design For Minimum Number Of Parts, Development Of Modular Design, minimising Part Variations, Design Of Parts To Be Multi-Functional, Multi-Use, Ease Of Fabrication, PokaYoka Principles.	**6**
2.	**GEOMETRIC ANALYSIS** Process Capability, Feature Tolerance, Geometric Tolerance, Surface Finish, Review of Relationship Between Attainable Tolerance Grades and Difference Machining Processes. Analysis of Tapers, Screw Threads, Applying Probability to Tolerances. **FORM DESIGN OF CASTINGS AND WELDMENTS** Redesign of Castings Based On Parting Line Considerations, Minimizing Core Requirements, Redesigning Cast Members Using Weldments, Use of Welding Symbols. **MECHANICAL ASSEMBLY** Selective Assembly, Deciding The Number Of Groups, Control Of Axial Play, Examples, Grouped Datum Systems - Different Types, Geometric Analysis And Applications-Design Features To Facilitate Automated Assembly.	**14**
3.	**TRUE POSITION THEORY** Virtual Size Concept, Floating and Fixed Fasteners, Projected Tolerance Zone, Assembly with Gasket, Zero True Position Tolerance, Functional Gauges, Paper Layout Gauging, Examples. Operation Sequence for Typical Shaft Type of Components. Preparation of Process Drawings for Different Operations, Tolerance Worksheets and Centrality Analysis, Examples.	**8**
4.	**DESIGN FOR MANUAL ASSEMBLY** Product Design For High Speed Automatic Assembly And Robot Assembly, Printer Circuit Board Assembly, Feasibility Study For Assembly Automation.	**6**
5.	**AUTOMATIC ASSEMBLY TRANSFER SYSTEMS** Automatic Feeding and Orienting –Vibratory Feeders, Automatic Feeding and Orienting Mechanical Feeders, Feed Tracks, Parts Placement Mechanisms Performance and Economics of Assembly	**8**

Course Outcomes:	
1	The student shall be able to design casting process and weldments for manufacturing industry
2	The student shall be able to design components and assemblies after performing analysis and feasibility study.
3	The student shall be able to simplify the manufacturing process and modify design so as to reduce the cost for manufacturing relevant to manufacturing industry.
4	The student shall be able to assess the risks of manufacturing processes andtake appropriate measures throughapplication of some latest scientific tools.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Hand Book of Product Design for Manufacturing", Bralla James G, McGraw Hill,	1986
2	"Concurrent Engineering Fundamentals - VOL II", Biren Prasad, Prentice Hall	1997
3	"Product design and development", Ulrich Karl.T, Eppinger Stephen D, McGraw Hill	1994

Course Name	**:**	**SPECIAL TOPICS IN INDUSTRIAL ENGINEERING**
Course Code	**:**	**PR2022**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The objective of the subject is to introduce the concepts of business process, Six Sigma, Reverse Engineering, 6 sigma, Lean and Agile manufacturing
2	The objective of the subject is to make students learn and apply the various concepts of Six Sigma, Reverse Engineering, Lean and Agile manufacturing.

Total Number of Lectures – 42

S. No.	Course Content	Number of Lectures
1.	**BUSINESS PROCESS** Introduction, Study Of Various Business Tools, Methodologies, Strategies And Decision Making Through Case Studies Of Different Business Organizations And Projects	**3**
2.	**SIX SIGMA:** Basic Concepts In Quality Management, TQM, Cost Of Quality, Quality Engineering And Six Sigma, Review Of Probability And Statistics, Test Of Hypothesis, DMAIC Process For Process And Design Improvement, Acceptance Sampling, SPC (Statistical Process Control),Process Capability, Gage Reproducibility And Repeatability, Quality Function Deployment	**4**
3.	**DESIGN OF EXPERIMENTS:** Basic Concepts, ANOVA, EVOP; Fractional, Full And Orthogonal Experiments, Regression Model Building, Taguchi Methods For Robust Design, Six Sigma Sustainability; Case Studies.	**3**
4.	**INTRODUCTION TO LEAN MANUFACTURING:** Objectives Of Lean Manufacturing, Key Principles And Implications Of Lean Manufacturing, Traditional Vs Lean Manufacturing	**4**
5.	**LEAN MANUFACTURING CONCEPTS:** Value Creation And Waste Elimination-Main Kinds Of Waste, Pull Production-Different Models Of Pull Production, Continuous Flow-Continuous Improvement, Kaizen-Worker Involvement -Cellular Layout-Administrative Lean, Toyota Production System	**4**
6.	**AGILE MANUFACTURING:** Definition, Business Need, Conceptual Frame Work, Characteristics, Generic Features, CAPP For Agile Manufacturing, Aggregate Capacity Planning And Production Line Design / Redesign In Agile Manufacturing., Cellular Manufacturing, Concepts, Examples, Robust Design Approach, Approaches To Enhance Agility In Manufacturing, Role Of QFD, Managing People In Agile Organization, Approaches, Applications Of Multimedia To Improve Agility In Manufacturing	**4**
7.	**AGILE SUPPLY CHAIN MANAGEMENT** Principles, IT/IS Concepts In Supply Chain Management, Enterprise Integration And Management In Agile Manufacturing, Concepts, Agility, Adaptability, Strategic Options In Agile Manufacturing	**4**
8.	**REVERSE ENGINEERING**	**4**

	Introduction, Scope And Tasks Of RE, Process Of Duplicating, Definition And Use Of Reverse Engineering, Reverse Engineering As A Generic Process	
9.	**TOOLS AND TECHNIQUES FOR REVERSE ENGG.** Object Scanning: Contact Scanners, Noncontact Scanners, DestructiveMethod, Coordinate Measuring Machine, Point Data Processing: PreprocessingAnd Post Processing Of Captured Data, Geometric Model Development, Construction Of Surface Model, Solid Model, Noise Reduction, Feature Identification, Model Verification	**4**
10.	**RAPID PROTOTYPING** Introduction, Current RP Techniques And Materials, Stereo Lithography, Selective Laser Sintering, Fused Deposition Modeling, Three-Dimensional Printing, Laminated Object Manufacturing, MultijetModeling, Laser-Engineered Net Shaping, Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	**4**
11.	**INTEGRATION** Cognitive Approach to RE, Integration of Formal And Structured Methods In Reverse Engineering, Integration Of Reverse Engineering And Reuse. Legal Aspects Of Reverse Engineering: Introduction, Copyright Law	**4**

Course Outcomes:	
1	Learn and apply the concepts of Reverse Engineering, Six Sigma, Lean, Flexibility, and Agility as applied in automotive manufacturing and supply chain management
2	Learn and apply the Strategies/Methodologies relating to such topics as Production Planning and Control, Factory Dynamics

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Toyota production System", Ohio Seichi, McGraw Hill	2001
2	"Reverse Engineering", Katheryn, A. Ingle, McGraw-Hill	1994
3	"Data Reverse Engineering", Aiken Peter, McGraw-Hill	1996
4	"An Introduction to Six Sigma and Process Improvement", Evans, J R and W M Lindsay, Cengage	2005

Course Name	**:**	**INDUSTRIAL HAZARDS AND SAFETY**
Course Code	**:**	**PR2023**
Credits	**:**	**4**
LTP	**:**	**3-1-0**

Course Objectives:	
1	At the end of the course the students should have knowledge about various types of industrial hazards
2	The objective of this course is to give students enough understanding regarding various safety procedures and protocols

Total Number of lectures: 42

S. No.	Course Content	Number of Lectures
1.	**PHYSICAL HAZARDS** Noise, Properties of Sound, Occupational Damage, Risk Factors, Sound Measuring Instruments, Noise Control Programmes. Ionizing Radiation, Types, Effects, Monitoring Instruments, Control Programmes, OSHA Standard - Non-Ionizing Radiations, Effects, Types, Radar Hazards, Microwaves And Radio Waves, Lasers, TLV- Cold Environments, Hypothermia, Wind Chill Index, Control Measures- Hot Environments, Thermal Comfort, Heat Stress Indices, Acclimatization, Estimation And Control.	**10**
2.	**CHEMICAL AND NUCLEAR HAZARDS** Recognition Of Chemical Hazards- Types, And Concentration, Exposure Vs.Dose, TLV, Methods Of Evaluation, Process Or Operation Description, Field Survey, Sampling Methodology, Air Sampling Instruments, Types, Measurement Procedures, Instruments Procedures, Gas And Vapour Monitors, Dust Sample Collection Devices, Personal Sampling. Methods Of Control - Engineering Control, Nuclear Hazards, Disposal Of Nuclear Wastes, Safety Measures In Nuclear Plants	**8**
3.	**BIOLOGICAL AND ERGONOMICAL HAZARDS** Classification of Biohazardous Agents, Examples, Bacterial Agents, Rickettsialand Chlamydial Agents, Viral Agents, Fungal, Parasitic Agents, Infectious Diseases, Biohazard Control Programmes, Employee Health Programmes, Laboratory Safety Programmes, Animal Care and Handling-Biological Safety Cabinets, Building Design. Work Related Musculoskeletal Disorders, Carpal Tunnel Syndrome (CTS), Tendon Pain, Disorders Of The Neck, Back Injuries.	**8**
4.	**OCCUPATIONAL HEALTH AND TOXICOLOGY** Concept and Spectrum of Health, Functional Units and Activities of Occupational Health Services, Pre Employment And Post Employment Medical Examinations, Occupational Related Diseases, Levels Of Prevention Of Diseases, Notifiable Occupational Diseases, Their Effects And Prevention. Industrial Toxicology, Local, Systemic And Chronic Effects, Temporary And Cumulative Effects, Carcinogens Entry Into Human Systems.	**8**
5.	**OCCUPATIONAL PHYSIOLOGY** Man As A System Component, Allocation Of Functions, Efficiency Occupational Work Capacity, Aerobic And Anaerobic Work, Evaluation Of Physiological Requirements Of Jobs, Parameters Of Measurements, Categorization Of Job Heaviness, Work Organization, Stress – Strain , Fatigue,	**8**

	Rest Pauses, Shift Work, Personal Hygiene.	

Course Outcomes:	
1	Classify different types of industrial hazards
2	Identify and apply the required safety protocols with respect to given hazard
3	Identification of various health related issues and their prevention

Bibliography:

S. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	"Hand book of Occupational Safety and Health", National Safety Council, Chicago	1982
2	"Encyclopediaof Occupational Health and Safety", Vol. I and II, International Labour Office, Geneva,1985	1985
3	"Occupational Safety and Health Management", by Thomas J. Anton, 2nd Ed.	1989
4	"Occupational Safety Management and Engineering", by Willie Hammer and Dennis Price, ISBN: 0-13-896515-3	2001

Course Name	**:**	**ENGINEERING ANALYSIS AND DESIGN**
Course Code	**:**	**PR2024**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The objective of the subject is to uphold a steadiness between theory, numerical computation and practical solutions to engineering systems.
2	The objective of the subject is to enable to students understand role and importance of engineering analysis through various methods

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Introduction, The Design Process, Engineering Design Versus Analysis, Conventional Versus Optimum Design Process, Basic Terminology and Notation. Design Variables, Cost Function, Design Constraints And General Mathematical Models For Optimum Design And Case Studies.	**5**
2.	**ENGINEERING ANALYSIS** Role of Analysis, The Design Spiral, Computer Aided Engineering Analysis: Visualization, Analysis and Redesign, Statistical Considerations, Safety and Reliability. Case Studies On Common Engineering Designs And Mechanisms Such As: Sewing Machine, Single Point Cutting Point, Riser Design, Design of Key andbasic concepts in design of hydraulic actuators.	**5**
3.	**REVERSE ENGINEERING** Introduction, Steps, Rapid Prototyping, Rapid Manufacturing and Applications. Design for Manufacturing and Assembly (DFMA). Case Studies On DFMA.	**5**
4.	**LEARNING FROM FAILURE** Various Failure Case Studies, Failure Of Machine Components, Failure Modes And Effect Analysis (FMEA) And Case Studies.	**5**
5.	**AESTHETICS IN ENGINEERING DESIGN** Concept Of Visual Design, Written, Oral And Poster Presentations And Case Studies.	**5**
6.	**DESIGN OF EXPERIMENTS AND OPTIMIZATION** Strategy of Experimentation, Basic Principles, Guidelines For Designing Experiments, Sampling And Sampling Distribution. Design Of Experiments With A Single Factor And Multi Factor Design, Analysis Of Variance (ANOVA) And Introduction To Factorial Design.	**5**
7.	**TAGUCHI METHODOLOGY** Design Of Experiments - The Taguchi Approach, Taguchi Philosophy, Concept Of The Loss Function, Experiment Design Strategy, Areas Of Application, Quality Characteristic, Taguchi Quality Strategy, Selecting Design Parameters For Reduced Variation, Signal To Noise Ratio (S/N Ratio), Analysis Of Variance (ANOVA), Confirmation Experimentation, F-Test.	**5**
8.	**FINITE ELEMENTS IN ENGINEERING** Introduction, Stress Strain Relationship, Temperature Effects, Potential Energy and Equilibrium. Von Mises Stress. Finite Element Modeling (One Dimension Only) Coordinate And Shape Functions And Potential Energy Approach.	**5**

9.	**ENGINEERING ETHICS AND TEAM WORK** Engineering Ethics, Intellectual Property Rights, Case Studies And Presentations.	**2**

Course Outcomes:	
1	Understand basic theoretical principles in engineering design and optimization
2	Understand a wide range of engineering related designs and mechanisms.
3	Apply "Design of Experiment technique" to some engineering problems.

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"A primer on Taguchi Methodology", Ranjit K Roy	2011
2	"Optimization for Engineering Design", Kalyanmoy Deb, PHI	2010
3	"Product Design and Manufacturing", AK Chitaleand Gupta R C., PHI (6th Edn.)	2011
4	"Introduction to Finite elements in engineering", Chandrupatla&Belegundu, Prentise Hall	2006
5	"Design and Analysis of Experiments", Douglas C Montgomery- Wiley	2005

Course Name	**:**	**SENSOR MANUFACTURING AND PROCESS CONTROL**
Course Code	**:**	**PR2025**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	At the end of the course the students should be able to have basic knowledge of advance sensors & its applications i.e., integration if mechanical engineering with electrical & electronics engineering.
2	The objective of the subject is to enable to students to apply the fundamentals of sensors manufacturing and process control in some industry oriented applications.

Total Number of Lectures – 42

S. No.	**Course Contents**	**Number of Lectures**
1.	**INTRODUCTION** Description Of Measuring Devices And Dynamic Characteristics, Active And Passive Sensors And Transducers, Classifications.	**4**
2.	**MOTION SENSORS** Resistive Strain Gauge, LVDT, RVDT, Capacitive, Piezo, Seismic Pick-Ups, VibrometersAnd Accelerometers	**4**
3.	**VARIOUS SENSORS** Sensors And Transducers For: Flow, Temperature, Force, Pressure And Torque Sensors; Current, Torque And Speed Measurements Using Digital Measurement Techniques.	**6**
4.	**OPTICAL SENSORS: LASERS** Photo-Detectors and Optical Fiber as Sensors, Sensors in Robotics: Classification, Characteristics, Internal Sensors: Position, Velocity, Acceleration Sensors, Force Sensors, External Sensors: Proximity, Touch And Slip Sensors. Robotic Vision, Process Of Imaging, Architecture Of Robotic Vision Systems, Image Acquisition, Components Of Vision System, Image Representation, Image Processing.	**10**
5.	**ADVANCED SENSORS** Semiconductor Sensors, Hall Elements. Silicon Sensors For Sensing Radiation, Mechanical, Magnetic, Chemical And Other Signals, Catalytic Devices, Gas Sensors And Acoustic Sensors.	**8**
6.	**SENSOR BASED CONTROL** Types of Controllers, Electrical, Pneumatic and Hydraulic Prime Movers and Associated Control Hardware, Closed Loop Control of Microcomputer Based Drives. Relay Control Systems and PLC Systems and Programming, Control Including Sequence Control. Sensor Based Control Of Various Actuators, Mechatronic Devices And Autonomous Mobile Robots.	**10**

Course Outcomes:	
1	Understand the working principlesof various sensors.
2	Calibrate a sensor for acquiring data.
3	Develop a control scheme based on sensor feedbacks.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Introduction to sensors", J. Vetelinoand A .Reghu, CRC Press	2010
2	"Handbook of Modern Sensors: Physics, Designs and Applications" .J. Fraden	2010
3	"Mechanical Measurements", T. G. Beckwith, R. D. Marangoni and J. H. Lienhard V., Pearson Prentice Hall	2009
4	"Sensor Technology Handbook", J. S. Wilson, Newnes	2004
5	"Sensors and Actuators", C.W. de Silava, CRC Press	2016
6	"Control in Robotics and Automation: Sensor-Based Integration", B. K. Ghosh, T. J. Tarn and N. Xi, Academic Press	1999

Course Name	**:**	**ENTERPRISE AND CYBER SECURITY IN MFG.**
Course Code	**:**	**PR2026**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	Techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.
2	Provide fundamental knowledge on cloud based manufacturing, security challenges and risks associated with different cloud deployment models along with technologies necessary to protect manufacturing systems.
3	Provide working knowledge of using different data mining techniques to identify cyber threats to a manufacturing system.

Total Number of Lectures – 42

S. No.	**Course Contents**	**Number of Lectures**
1.	**ENTERPRISE APPLICATION DEVELOPMENT** Describe The Nature And Scope Of Enterprise Software Applications, Design Distributed N-Tier Software Application, Research Technologies Available For The Presentation, Business And Data Tiers Of An Enterprise Software Application, Design And Build A Database Using An Enterprise Database System, Develop Components At The Different Tiers In An Enterprise System, Design And Develop A Multi-Tier Solution To A Problem Using Technologies Used In Enterprise System, Present Software Solution.	**8**
2.	**ENTERPRISE SYSTEMS ADMINISTRATION** Design, Implement And Maintain A Directory Based Server Infrastructure In A Heterogeneous Systems Environment, Monitor Server Resource Utilization For System Reliability And Availability, Install And Administer Network Services (Dns/Dhcp/Terminal Services/Clustering/Web/Email).	**7**
3.	**AN OVERVIEW OF AN INDUSTRIAL CONTROL SYSTEM** Industrial control system history-modbusandmodbus TCP / IP – Profinet-Common IT protocols found in the ICS- Anatomy ICS attack scenario, The converged plant wide Enterprise-The safety zone-the manufacturing	**8**
4.	**MANUFACTURING INTRODUCTION TO INDUSTRIAL NETWORKING** Common Topologies- Network Segmentation-Network Services-The Enterprise Zone-The Cpwe Industrial Network Security Framework, Consequences Of Successful Cyber Incident-Cyber Security And Safety-Common Industrial TargetsCommon Attack Methods- Attack Trends-Industrial Application Layer Attacks,	**10**
5.	**CYBER SECURITY AND RISK MANAGEMENT** Methodologies For Accessing Risk Within Industrial Control System-System Characterization, Cyber Physical Systems - Safety And Security Of Cyber Physical Systems- Cyber-Attacks And Measures In Cyber-Physical Systems - Cyber Risks In Industrial Control Systems - Costing Security Solutions	**9**

Course Outcomes:	
1	Develop technical expertise in security of cyber-physical systems.
2	Categories intrusion and security breaches to cyber-physical systems
3	Propose security solutions for cyber-physical systems
4	Analyze and solve cyber security and system safety issues in cyber-physical systems

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Enterprise Software Security", Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Addison Wesley	2014
2	"Industrial Cyber security-Efficiently secure critical infrastructure systems", Pascal Ackerman, Packt Publishing Ltd., Bringham	2017
3	"Industrial Network Security- Securing Critical Infrastructure Networks for smart Grid, SCADA, and other Industrial Control Systems", Eric D. Knapp and Joel Thomas Langill, Syngress is an Imprint of Elsevier,	2015
4	"Secure Software Design", Theodor Richardson, Charles N Thies, Jones & Bartlett	2013

Course Name	**:**	**CNC MACHINES AND PROGRAMMING**
Course Code	**:**	**PR4006/ PR5102/ PR6003**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1	To provide basic concepts of constructional details of CNC machines with programming and their applications
2	At the end of the course, the students should be perform experiments based on the CNC programming

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION** Basics and Need of NC/CNC/DNC, Applications and Advantages of CNC Machines– Its Growth and Development, Classifications of CNC Machines.	**3**
2.	**CONSTRUCTIONAL DETAILS CNC MACHINES** Machine Structure, Slide-Ways, Motion Transmission Elements, Automatic Tool Changer, Multiple Pallet Systems, Feed-Back Devices, Machine Control Unit, And Interpolators, Applications of NC Systems, Merits and Demerits.	**8**
3.	**CNC PART PROGRAMMING** Introduction to Part Programming, Axis Identification and Coordinate Systems, Structure of CNC Part Program, Programming Formats, Radius and Length Compensation Schemes, Advanced Programming Features & Canned Cycles, Computer Aided CNC Part Programming Using APT Language.	**15**
4.	**ADAPTIVE CONTROL SYSTEMS** Adaptive Control with Optimization, Adaptive Control with Constraints, ACC System for Turning, Adaptive Control of Grinding, Limitation of Adaptive Control Systems.	**8**
5.	**CO-ORDINATE MEASURING MACHINES** Basic Types of Measuring Machines, Operating Modes, Programming Soft-Wares, Measurement and Inspection Capabilities, Flexible Inspection Systems, Inspection Probes.	**8**

S. No	**List of Experiments**	**Number of Hours**
1	To learn and write part programming for given job	**1**
2	To perform simulation operations for drilling, milling etc. on Master CAM software for given job	**2**
3	To perform drilling operation on VMC machine using Master CAM Software	**2**
4	To perform milling/ engraving operation on VMC machine using Master CAM Software	**2**
5	To make a report on VMC learning and maintenance.	**2**
6	Gear checking: To measure the geometric features of a gear, such as tooth profile tooth thickness, pitch, and helix angle.	**2**
7	Thread checking: To inspect the cylindrical and conical threads	**1**
8	Cam checking: To evaluate the accuracy of physical cams relative to design specifications.	**2**

Course Outcomes:	
1	Able to understand the construction details of CNC machines
2	Able to able to write the part program for some given jobs.
3	Able to understand the working principle of adaptive control and their applications on various machining processes
4	Able to handle the CMM for various measurements.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Numerical Control and Computer Aided Manufacturing", Kundra T K, Rao P N, Tewari N K, Tata McGraw-Hill	2002
2	"Computer Control of Manufacturing Systems", Koren Y, McGraw-Hill	1986
3	"CNC machines",Pabla B.S & M Adithan, New Age Publishers, New Age International Pvt Ltd Publishers	2009
4	"CAD/CAM: Computer-Aided Design and Manufacturing",Groover M., Zimmers E., Kindle Edition	2003
5	"Computer Aided Manufacturing", Chang, T.C., Wysk, R. A. and Wang, H.-P. 3rd Ed., Prentice Hall	2005
6	"Automation, Production Systems, and Computer Integrated Manufacturing, Groover, M P, Prentice-Hall	2007

Course Name	**:**	**ADVANCE ERGONOMICS & WORK DESIGN**
Course Code	**:**	**PR4101/ PR5201/ PR6005**
Credits	**:**	**4**
LTP	**:**	**3-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to describe and significance of principles of ergonomics and work design.
2	At the end of the course, the students should be able apply the concepts of advanced ergonomics for industrial applications.

Total Number of lectures: 42

S. No.	Course Content	Number of Lectures
1.	**INTRODUCTION** Introduction And Relevance To Work System Design, Importance Of Ergonomics In Present Day Scenario, Definition & Fundamentals Of Ergonomics: Historical Perspectives, Objectives and Functions	**10**
2.	**ANTHROPOMETRY** Human Body, Anthropometrics, Postures; Stand, Sitting, Squatting And Cross-Legged Postures, Anthropometric Measuring Techniques, Body Supportive Devices, Vertical and Horizontal Work Surface, Design of an Ergonomic Chair	**10**
3.	**HUMAN FACTORS** Behavioral Aspects, Cognitive Issues, Mental Work Load, Human Error	**8**
4.	**ERGONOMIC DESIGN** Design Methodology And Criteria For Designing, Design For Improving Occupational Safety And Reduction In Fatigue And Discomfort, Work System Design, Environmental Factors, Visual Issues In Design, Case Studies	**10**
5.	**CASE STUDIES** Design Modifications In Existing Products From The Ergonomics Point Of View	**4**

S. No.	List of Experiments	No. of hrs
1	Ergonomic evaluation for welding processes	**7**
2	Design of an ergonomic chair	**7**

Course Outcomes:	
1	Classify different ergonomic principles.
2	Understand various factors of work design.
3	Applying the concepts of work design for some real life applications.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Publication Yr.
1	"Ergonomics Interventions for Health and Productivity", Singh, S (Edt), Himanshu Publications, Udaipur, New Delhi,	2007
2	"Handbook of Human Factors & ergonomics" Salvendy G., John Wiley & Sons	1998
3	"Human Factors in Product Design", Green, W.S. &Jordan, Taylor & Francis	1999

Course Name	**:**	**VALUE ENGINEERING**
Course Code	**:**	**PR4102/ PR5202/ PR6007**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	To understand the concept to f-value analysis and value engineering.
2	To understand the various techniques of solving the problems pertaining to value engineering in manufacturing and service industries.

Total Number of lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1.	**CONCEPTS, APPROACHES OF VALUE ANALYSIS & ENGINEERING:** Concept To F-Value, Maximum Value, Normal Degree Of Value, Importance Of Value, Value Oriented Work, Use Of Value Resources, Value Work Expands Market & Jobs, Approach to Prepare Mind For The Value Analysis Techniques	**10**
2.	**CLASSIFICATION AND EVALUATION OF FUNCTIONS** Use And Aesthetic Functions, Identification, Clarification And Naming Functions, Quantifying Functions, Unifying The Function And Its Specifications, Analysis Of Aesthetic Functions, Classification Of Functions Evaluation Of Function	**8**
3.	**PROBLEM SOLVING SYSTEM** The Value Analysis Job Plan: Information Step, Analysis Step, Creativity Step, Judgment Step, Development Planning Step, Case Study.	**6**
4.	**SETTING & SOLVING MANAGEMENT-DECISION-TYPE PROBLEMS** Types of Management Problems, Setting The Precise Problem, Case Study: Company building manufacturing facilities for important Purchased Assemblies	**8**
5.	**EFFECTIVE ORGANIZATION FOR VALUE WORK** Smallest and Smaller Business, One Man Set Up, Two Man Set Up, Three Man Set Up, Four or More Consultant, Structuring The Company, Decision Criteria-Performance And Time, Decision Criteria-Performance, Time, And Cost, Understanding The Research And Development Problem.	**10**

Course Outcomes:	
1	Student should be able to understand advanced techniques for value engineering.
2	Student should be able to know about value engineering concepts and their applications.

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Value Analysis"s Tear Down- A New Process forProduct Development and innovation", Kaoufman Jerry, Yashihiko Sato Industrial Press	2004
2	"Creativity and Innovation: Rapidly Improving Processes,Product Development and Solving ComplexProblems", Charles W, FASTJ.Ross Publishing	2007
3	"A framework for value management practice",Michel Thury, Project Management Institute publishing	2013
4	"Techniques of Value Analysis and Engineering", Lawrence D. Miles, MCGraw- Hill Book Company	2015

Course Name	**:**	**QUALITY MANAGEMENT SYSTEM**
Course Code	**:**	**PR4107/ PR5203/ PR6008**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	To understand the concept of Quality engineering and management
2	At the end of the course, the students should be able learn and design basic tolerances.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of lectures**
1.	**INTRODUCTION** Introduction to Quality Management. History of Quality. Basic QM Principles. The Overview of Quality Gurus and Their Concepts: Joseph Juran, Kaoru Ishikawa, Philip Crosby, W. Edwards Deming, Introduction to Deming's 14 Points of Quality, International Organization for Standardization. ISO Members. ISO Standards and Rules.	**10**
2.	**STATISTICAL METHODS INMANUFACTURING** Use of Statistics to Ensure Quality of Manufacturing Processes, To Predict the Reliability of Products and Processes and to Improve Manufacturing Designs and Processes.	**8**
3.	**QUALITY ENGINEERING IN PRODUCTION SYSTEMS** Quality Value and Engineering, Quality Engineering in Product Design and Design of Production Processes, Taguchi's Philosophy ff Robust Design, Loss Function and Quality Level, Derivation of Loss Function, Uses of Loss Function, The Loss Function and Justification For Improvements.	**10**
4.	**TOLERANCE DESIGN** Quality Levels And Types Of Tolerances, Determination Of Tolerances, Process Capability And Product Tolerances, Statistical Build Of Tolerances.	**6**
5.	**RELIABILITY ENGINEERING** 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. Series Configuration, Parallel Configuration – Combined Series Parallel Systems Markov Analysis	**8**

Course Outcomes:	
1	Student should be able to apply the concepts ofreliability engineering
2	Student should be able to understandand apply statistical methods in manufacturing.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Quality Engineering in Production Systems by Taguchi", Elsayed and Hsiang, McGraw Hill Publication.	1989
2	"Quality Reliability and Process Improvement", Emick Norbert Lloyd, Industrial Press Inc. New York.	1985

Course Name	**:**	**TECHNOLOGY MANAGEMENT**
Course Code	**:**	**PR4106/ PR5204/ PR6009**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	At the end of the course, the students should be able to describe the evolution in the technology management.
2	At the end of the course, the students should be able to contribute along with inputs for facing the changing technology.

Total Number of Lectures- 42

S. No.	**Course Content**	**Number of Lectures**
1.	**TECHNOLOGY MANAGEMENT** Issues And Applications, Concepts Of Technology; Role And Importance Of Technology Management, Dimensions Of Technology Management, Technology Management In India.	**5**
2.	**TECHNOLOGY CHANGE:** Nature of Technology Change, Motivation for Technology Change. Invention And Innovation, Technology Life Cycle, Technology Monitoring	**5**
3.	**TECHNOLOGY FORECASTING** Objectives And Approaches, Methodology Of Technological Forecasting, Delphin Technique, Growth Curves, Morphological Analysis Technological Discontinuities Indian Technology Vision 2020.	**5**
4.	**MANAGEMENT OF R & D** Corporate Strategy, Selection of R & D Projects, Managing R & D, Radical and Cyclic Innovation Processes. Technology Strategy And Innovation	**5**
5.	**TECHNOLOGY ABSORPTION AND DIFFUSION** Technology Dependence, Concepts in Technology Absorption, Constraints In Technology Absorption. Management Of Technology Absorption, Technology Absorption And Adaptation Scheme (TAAS), Concept Of Diffusion Of Technology, Perspective On Diffusion, Developing Diffusion Strategies	**5**
6.	**TECHNOLOGY TRANSFER** Models Of Technology Transfer, Technology Transfer Modes, Dimensions Of Technology Transfer, Dimensions Of Technology Transfer, Pricing Of Technology Government Policies Of Technology Transfer	**5**
7.	**ROLE OF INTELLECTUALPROPERTY RIGHTS** Nature Of IPR, Patent, Trademark And Copy Rights Legal Aspects	**3**
8.	**MANAGING PROCESS TECHNOLOGY** Continuous Improvement Technology Integration, Product And Process Technology, Techniques Of Improvement, Economics If Improvement.	**4**
9.	**TECHNOLOGY AS A COMPETITIVE STRATEGY** Competitive Analysis, Core Competitive Competencies, Technology Leadership, Adoption of New Technology, Marketing Of New Technology. Case Studies On Technology Management	**5**

Course Outcome:	
1	Identify the different techniques to manage changing technology
2	Understand the importance of technology changes and develop adaptive strategies

Bibliography:

S. No.	Name of Book/Author/ Publisher	Year of Publication
1	"Total Quality Management for Engineers", M Zaire, Woodhead publishing Ltd.	2015
2	"Strategic Technology Management", Frederick Betz, McGraw Hill	2009
3	Technology, Innovation, and Educational Change: A Global Perspective", Robert B. Kozma	2003

Course Name	**:**	**PRODUCT DESIGN AND DEVELOPMENT**
Course Code	**:**	**PR4108/ PR6010**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objective:	
1	At the end of the course, the students will be able to understand the concept of product design, development and planning.
2	At the end of the course, the students will be able apply the product design concepts in the actual industry application.

Total Number of Lectures- 42

S. No.	Course Content	Number of Lectures
1.	**UNDERSTANDING DESIGN** Design & Its Nature, Design Activities: Design Exploration, Design Generation, Design Evaluation, Design Communication, Design Ability: Human Brain & Whole Brain Thinking, Intuition Vs. Logical Thinking, Difference Between Scientist/Engineer & A Designer, Design Problems: Design Brief, Ill-Defined Problems, Final Design Description, Four Stage Design Process Model	**6**
2.	**PRODUCT DEVELOPMENT** What Is Product Development, Characteristics Of Successful Product Development, Who Designs & Develops Products, Challenges Of Product Development, Phases Of Product Development Process	**4**
3.	**CONSTANT AND TIME DEPENDANT FAILURE MODELS** Exponential, Weibull, Normal And Lognormal Distributions	**2**
4.	**PRODUCT PLANNING** Product Planning, Types Of Product Development Projects, Product Planning Process (Steps).	**2**
5.	**CONCEPT DEVELOPMENT PHASE** Identifying Customer Needs Product Specifications: What Are Specifications, When Are Specifications Established, Establishing Target Specifications. Setting The Final Specifications .The Activity Of Concept Generation, A Five-Step Method Concept Selection & Concept Testing	**4**
6.	**SYSTEM LEVEL DESIGN** Product Architecture, Industrial Design	**2**
7.	**DETAIL DESIGN** Design For Manufacturing & Robust Design ,Computer Aided Design: Geometric Modeling Approaches, Wireframe & Surface Modeling, NURUBS, Solid Modeling, Features, Parametric &Variational Design, Computer Aided Engineering Analysis, CAD/CAM Data Exchange, Rapid Prototyping	**4**
8.	**TESTING & REFINEMENT** Prototyping Basics, Principles Of Prototyping, Prototyping Technologies, Planning For Prototypes	**4**
9.	**TYPES OF MAINTENANCE** Corrective, Breakdown, Predictive, Replacement, Preventive And Proactive Maintenance Strategies, Preventive Maintenances V/S. Repair, Computerized Maintenance Management System, Reliability Under Preventive Maintenance.	**4**

10.	**DESIGN FOR MAINTAINABILITY** Quantifiable measures of maintainability, maintainability management tasks during the product life cycle, life cycle costing, life cycle cost estimation models, spare parts management	**4**
11.	**INTRODUCTION TO TPM AND RCM** Classification, Principles, applications and case studies	**2**
12.	**RAPID PROTOTYPING METHODS** Liquid Based RP methods, Solid Based RP Methods, Powder Based Methods	**4**

Course Outcome:	
1	Students should be able to understand the concept of prototyping
2	Students should be able to design a product using computer-aided design.
3	Students should be able to carry out product development and planning process.

Bibliography:

S. No.	**Name of Book/Author/ Publisher**	**Year of Publication**
1	"Product Design & Development" K.T. Ulrich & S.D. Eppinger, ,TMH	2009
2	"Engineering Design Methods-Strategies for Product Design" Cross N., John Wiley & Sons	2008
3	"Product Design for Manufacture and Assembly"Boothroyd G., Dewhurst P., and Knight, Marcel Deckker, 2nd Ed.	2002

Course Name	**:**	**INDUSTRY 4.0 AND IIOT**
Course Code	**:**	**PR4002**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1.	To provide students an introduction to Industry 4.0 (or the Industrial Internet) and its applications in the business world.
2.	Student will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges
3.	The students are exposed to the architectures, and various frameworks in IIoTand Cloud Computing.

Total Number of Lectures: 42

S. No.	**Course contents**	**Number of Lectures**
1.	**INTRODUCTION TO INDUSTRY 4.0** The Various Industrial Revolutions, Digitalization And The Networked Economy, Drivers, Enablers, Compelling Forces And Challenges For Industry 4.0, Comparison Of Industry 4.0 Factory And Today's Factory, Trends Of Industrial Big Data And Predictive Analytics For Smart Business Transformation, Internet Of Things (IoT), Cyber Physical Systems, Cybersecurity In Industry 4.0,:Support System For Industry 4.0.The Journey So Far: Developments In Usa, Europe, China, India And Other Countries, Strategies For Competing In An Industry4.0 World. Future Of Works And Skills For Workers In The Industry 4.0 Era, Strategies For Competing In An Industry 4.0 World	**14**
2.	**INDUSTRIAL INTERNET OF THINGS (IIoT)** Basics of Industrial IoT, Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Predictive Analytics. Industrial IoT-Layers. Role Of Data, Information, Knowledge And Collaboration In Future Organizations, Industrial IoT- Application	**8**
3.	**INDUSTRIAL IoT** Big Data Analytics And Software Defined Networks: IIoT Analytics -Introduction, Machine Learning And Data Science	**6**
4.	**INDUSTRIAL IoT: SECURITY AND FOG COMPUTING** Fog Computing In IIoT, Security In IIoT-Part I,Part II, Industrial IoT- Application Domains	**5**
5.	**INDUSTRIAL IOT- APPLICATION DOMAINS I** Healthcare, Power Plants	**2**
6.	**INDUSTRIAL IOT- APPLICATION DOMAINS II** Oil, Chemical And Pharmaceutical Industry, Applications Of UAVs In Industries, Real Case Studies	**3**
7.	**INTRODUCTION TO CLOUD COMPUTING** Cloud Models, Cloud Service Examples, Cloud-Based Services & Applications, Virtualization, Load Balancing, Scalability, Deployment, Replication, Monitoring, SDN, Network Function Virtualization, Map Reduce, Identity And Access Management, SLAs	**4**

S. No	List of Experiments	Number of Hours
1	Designing plan layout using IoT	6
2	Integration of CAD to CAM using IoT	4
3	Integration of robots with industry 4.0	4

Course Outcomes:	
1	Students should be able to outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world.
2	Students should be able to understand the drivers and enablers of Industry 4.0
3	Students should be able to implement a prototype of the IoT/cloud system design

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Industry 4.0: The Industrial Internet of Things", Alasdair Gilchrist, Apress, by Alasdair Gilchrist	2017
2	"Internet of Things, A hands-on approach", A. Bahgaand V. Madisetti, CreateSpace Independent Publishing Platform, 1st edition, ISBN: 978-0996025515.	2014
3	"Cloud Computing: Concepts, Technology & Architecture", T. Erl, Z. Mahmood, and R. Puttini, Prentice Hall, 1st edition, ISBN: 978-0133387520.	2013
4	"The Fourth Industrial Revolution",Klaus Schwab, Portfolio Penguin	2017

Course Name	**:**	**DESIGN FOR AUTOMATION**
Course Code	**:**	**PR4003/ PR6011**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to describe the importance of automation in industries.
2	At the end of the course, the students should be able to use the different techniques like hydraulic, pneumatic, electricaland PLC's to improve the automation.

Total Number of Lectures: 42

S. No.	**Course Contents**	**Number of Lectures**
1.	**OVERVIEW OF INDUSTRIAL AUTOMATION** Automation In Production Systems, Automation Principles And Strategies, Levels Of Automation, Automation At Device Level	**4**
2.	**PNEUMATIC CONTROL** Production, Distribution And Conditioning Of Compressed Air, Pneumatic Control Components, Pneumatic Actuators, Pneumatic Valves, Air-Hydraulic Equipment, Pneumatic Control System Design, Logic Control Circuits, Applications Of Electro Pneumatic, Circuit Design For Various Applications	**10**
3.	**HYDRAULIC CONTROL** Components Of Hydraulic Control System, Hydraulic Actuators, Hydraulic Valves, Accumulators, Hydraulic Circuit Design And Analysis	**8**
4.	**ELECTRICAL CONTROL** Electrical Actuators: Stepper Motors, DC And AC Motors, Motor Selection	**6**
5.	**SYSTEM MODEL ANALYSIS** System Model Analysis, Model Formulation, Transfer Functions, System Response, Linear System Analysis	**6**
6.	**PROGRAMMABLE LOGIC CONTROLLERS** PLC System Overview, PLC Features, Basic PLC Programming, PLC Selection, Examples Of PLC Industrial Applications	**8**

S. No.	**List of Experiments**	**Number of Hours**
1	Introduction to pneumatic/hydraulic/electrical elements used for automation	**2**
2	Use industrial grade sensors and transducer introduction and characteristics like proximity detector, linear encoder, rotary encoder, touch sensor, force sensor, accelerometer, RTDs, loadcells and LVDT for measurement	**2**
3	Use Various actuators such as relay, solenoid valve, process control valve and linear actuators for control applications	**2**
4	Relay logic diagram and ladder logic diagramusingfesto software & hardware pneumatic	**2**
5	Understandand perform experiments on timers & counter using FESTO software	**2**
6	Logic implementation for traffic Control Application with PLC HMI Simens software	**2**
7	Develop graphical user interface for some plant visited/ site searched	**2**

Course Outcomes:	
1	Choose different automation methods for a given application.
2	Identify the functioning of hydraulic/ pneumatic and electrical circuits.
3	Prepare a simple automation circuit comprise pneumatic/hydraulic, electric & PLC elements for simple automation and explain its different components.

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication
1	"Automation, Production Systems and Computer-Integrated Manufacturing", M.P. Groover, Pearson Education	2014
2	"Programmable Logic Controllers", R. Ackermann, J. Franz, T. Hartmann, A. Hopf, M. Kantel, B. Plagemann, Festo Didactic	2014
3	"Fluid Power with Applications" A.Esposito, Pearson Education India	2008
4	Pneumatic Systems: Principles and Maintenance, McGraw Hill Education	1995

Course Name	**:**	**INDUSTRIAL ROBOTICS**
Course Code	**:**	**PR4005**
Credits	**:**	**4**
LTP	**:**	**3-0-2**

Course Objectives:	
1	At the end of the course, the students should be able to describe the basic functioning, principles, classification and uses of robots in industrial applications.
2	At the end of the course, the students should be able to perform some experimental studies with industrial robots

Total Number of lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1.	**ROBOT TECHNOLOGY** Fundamentals, General Characteristics, Basic Components, Robot Anatomy, Robot Selection.	**4**
2.	**ROBOT CLASSIFICATION** Classification, Arm Geometry, Degrees Of Freedom, Power Sources, Types Of Motion, Path Control	**4**
3.	**ROBOT SYSTEM ANALYSIS** Robot Kinematics Modeling, DH Parameters, Forward And Inverse Kinematics, Robot Dynamics, Dynamic Properties Of Robots.	**4**
4.	**TRAJECTORY PLANNING** Cartesian Vs Joint Space Trajectory Planning, Polynomial Trajectories, Cubic AndQuintic Interpolation, Higher Order Trajectories, 4-3-4 Trajectory For Pick And Place Operation	**5**
5.	**ROBOT END EFFECTORS** Types Of End-Effectors, Mechanical Grippers, Gripper Force Analysis, Other Type Of Grippers, Special Purpose Grippers, Gripper Selection And Design, Process Tooling, Compliance	**5**
6.	**SENSORS** Robot Sensors, Sensor Classification, Proximity Sensors, Photoelectric Sensors, Micro Switches, Rotary Position Sensors, Usage And Selection Of Sensors.	**5**
7.	**VISION** Visual Sensing, Machine Vision- Image Acquisition, Digitization, Processing, Analysis And Interpretation, Machine Vision Applications, Other Optical Methods	**5**
8.	**ROBOT PROGRAMMING** Programming Methods, Programming Languages, Levels Of Robot Programming, Motion Interpolation, Sample Programs	**5**
9.	**INDUSTRIAL APPLICATIONS** Automation In Manufacturing, Robot Applications, Material Handling Applications, Processing Applications, Assembly Operations, Inspection Operations, Evaluating The Potential Of A Robot Application	**5**

S. No.	List of Experiments	Number of Hours
1	Robot programming using Teach Pendant and Computer	**4**
2	Pick and Place operation using robots	**2**
3	MIG welding using robots	**4**
4	Spot welding using robots	**4**

Course Outcomes:	
1	Classify different robots and identify their various components.
2	Understandand perform simple analysis on inverse kinematics.
3	Evaluate and select a gripper for different applications
4	Understand the roles of sensors, vision systems and applications of industrial robots

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Industrial Robotics", Groover. Weiss, Nagel andOrdrey, McGraw Hill	2012
2	"Ïntroduction to Robotics Mechanics andControll", Johan J. Craig, Pearson Edition.	2008
3	"Robot Technology Fundamentals", J G Keramas, Delmar Publications	1999

Course Name	**:**	**CREATIVITY IN ENGINEERING**
Course Code	**:**	**PR4007**
Credits	**:**	**4**
LTP	**:**	**3-1-0**

Course Objectives:	
1	At the end of the course, the students will learn collectively from talks, case studies, new methods and techniques.
2	At the end of the course, the students will learnthe theoretical aspects of creative design principles and innovation in product development.

Total Number of lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1.	**ELEMENTS OF CREATIVITY AND MAJOR THEORIES** Theoretical Aspects Of Creativity, Creative Processes: Art, Design And Science, Tools And Practice Of Creativity, The Defragmentation Of Creativity: Future Directions With An Emphasis On Educational Applications	**6**
2.	**SOCIAL AND ENGINEERING ASPECTS OF CREATIVITY** Creativity And A Human Dichotomy, Bridging Micro And Macro Levels In Creativity Research, Creativity In Design And Engineering, Creativity And Ideation, Creativity In Student Architects: Multivariate Approach	**8**
3.	**DESIGN AND INNOVATION** Innovation Design For Innovative Interactive Interactions, Product Development As Part Of Strategy	**5**
4.	**DESIGN INSPIRED BY NATURE** Introduction, Basic Principles, Structures And Properties, Designs Observed In Biological Systems, Navigation Of Insects, Fish & Migratory Birds, Biomimetic Composites, Allotropic Scaling Laws, Creating Bio-Inspired Solution Ideas Using Biological Research Articles, Application Of Biomimetic Principles To An Engineering Design	**9**
5.	**PRODUCT INNOVATION WITH CASE STUDIES** Innovation And Products, Various Cases Studies Based Upon Real Life Application Of Creativity In Engineering Will Be Studied In Detail.	**7**
6.	**DESIGN PROJECT**	**7**

Course Outcomes:	
1	The fundamentals of Design Methods for Creativity and Innovation in Product Development
2	Essential aspects of Creativity and Ideation, Creativity Tools and Methods, Iterative Creative Concept Generation Techniques and Innovation in Product Development

Bibliography:

S. No.	Name of Book/Authors/Publisher	Yearof Publication
1	"Multidisciplinary Contributions to the Science of Creative Thinking", David H. Cropley, Springer	2011
2	"Biomimetics: Nature based innovation "Bar-Cohen Y, CRC Press	2011
3	"Comparative biomechanics: Life's physical world" Vogel S; Princeton Univ. Press	2013

Course Name	**:**	**COMPUTER GRAPHICS & PRODUCT MODELING**
Course Code	**:**	**PR4008**
Credit	**:**	**4**
L T P	**:**	**3-0-2**

Course objectives:	
1	To provide an insight into fundamentals of Computer Graphics, Curve & surface design, Product modelling techniques and algorithms for geometric reasoning of CAD models
2	At the end of the course, the students will learn basic product designing and programming

Total Number of lectures: 42

S. No.	**Course Contents**	**Number of Lectures**
1.	**INTRODUCTION** Role of Computer Graphics in Product Modeling, Historical Perspective, Picture Creation, Product Modeling, Product Life Cycle Management	**3**
2.	**BASICS OF COMPUTER GRAPHICS** Elements Of A Graphics System, Graphics System Hardware, Graphical User Interface, Display Devices, CRT Display Monitors, Raster Graphics CRT Displays, LCD Monitors, Graphics Software, Vector And Raster Devices, BresenhamAnd ODA Raster Graphics Algorithms Viewing Pipeline Window, Viewport And Clipping Transformations	**6**
3.	**GEOMETRIC TRANSFORMATIONS** Types Of Geometric Transformations, Geometric Transformations In 2D, Cartesian Co-Ordinate Transformations, Homogenous Co-Ordinate System, Composite Transformations, Examples	**4**
4.	**PROJECTION TRANSFORMATIONS** Types Of Projections, Mathematics Of Projection, Orienting 3D Camera, Projection Vector And Plane Equations, Parallel Projections, Orthographic Projections, Multi-View Projections, Axonometric Projections, Oblique Projections, Perspective Projection, Single And Multi-Point Projections, Generalized Projection Transformation Matrix, Examples, Review Questions	**5**
5.	**GEOMETRIC DESIGN/SYNTHESIS OF PLANAR AND SPACE CURVES** Types Of Curves,Basis For Curve Representation, Techniques For Curve Design, Mathematical Basis For Curve Representation, Curve Design From Points, Synthetic Curve Design,Vector Valued Parametric And Rational Equations, Hermite, Bezier Curves, B Spline Curves, NURBS Curve, Examples, Review Questions	**5**
6.	**DESIGN OF SURFACES** Types of Surfaces, Representation Of Surfaces, Mathematical Basis For Surface Representation, Design Of Sweep Surfaces, Design Of Sweep Surfaces, ModelingOf Freeform Surfaces - Coons, Bezier And NURBS Patches, Surface Properties, Surface Normal, Curvature And Shape Of Surface, DevelopabilityOf Surface, Examples, Review Questions	**5**

7.	**GEOMETRIC MODELINGOF 3 D OBJECTS** Fundamentals of 3 D Product Modeling - Topology of Solids, Euler-Poincare Equations. Geometric Modeling Using Boundary Representation (Brep) And Set Theoretic (CSG) Approaches, Regularized Boolean Operations, Constraint Based Modeling, Examples, Review Questions	**5**
8.	**CONSTRUCTIVE SOLID GEOMETRYAND FEATURE BASED MODELING** Design By Features Approach, Geometric Reasoning Of CAD Models For Feature Extraction -Pattern Recognition And Graph-Based Approaches, Examples, Review Questions	**4**
9.	**PRODUCT DATA EXCHANGE STANDARDS** Data Structures For Product Modeling -Winged I Half Edge, Quad/Oct Trees, STL.Product Data And Interoperability, Evolution Of Data Standards – Historical Perspective, Initial Graphics Exchange Specifications (IGES), STEP Standard, Future Trends	**5**

S. No.	**Lists of Experiments**	**Number of Hours**
1	Design and Modelling of surfaces	**2**
2	CSG and Feature based Modelling	**2**
3	Freeform modelling of a given component	**2**
4	Mini Coding Project	**8**

Course Outcomes:	
1	Graphics enables a designer to synthetically create various product shapes, transform and view them in different settings, analyze them to check their functional performance and finally, prepare drawings and manufacturing instructions
2	Able to learn coding through different assigned graphics projects
3	Able to learn different types of projections and geometric transformation

Bibliography:

S. No.	**Name of Book / Authors / Publishers**	**Year of Publication**
1	"Computer Graphics and Product Modeling for CAD/CAM", S. S Pande, Narosa Publishing	2011
2	"Curves and Surfaces for Computer Aided Geometric Design", G Farin, Academic Press	1997
3	"Mathematical elements for Computer Graphics", D. F. Rogers and A Adams, McGraw Hill	1989
4	"Geometric Modeling", M. E. Mortenson, Wiley	1985
5	"Parametric and Feature based CAD-CAM", Jami J. Shah, M. Mantyala, John Wiley	2004

Course Name	**:**	**FLEXIBLE MANUFACTURING SYSTEM**
Course Code	**:**	**PR4103**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	The course has been designed to make the students understand the applications of flexible manufacturing systems and appreciate its importance
2	At the end of the course, the students will be able to learn FMS simulation

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1	**INTRODUCTION TO MANUFACTURING SYSTEMS** Different types of manufacturingSystems. Volume Variety relationships for understanding manufacturing systems, Flexibility and automation Different types of flexibility in manufacturing, Different types of FMS building blocks of flexible manufacturing system; Work station, Storage retrieved system, material handling systems and computer control system.	**10**
2	**MACHINING SYSTEM OF FMS** Horizontal & Vertical machining Centers. IntegratedMaterial Handling, Automated Guided Vehicles and modern trends.	**6**
3	**AUTOMATIC STORAGE AND RETRIEVAL SYSTEM** FMS control System. Cellular Manufacturing Systems.	**4**
4	**SCHEDULING :** Scheduling of Flexible Manufacturing Systems	**4**
5	**GROUP TECHNOLOGY** Past faculties, part classification and coding production flow analysis, Machine Cell design, Computer Aided Process Planning.	**6**
6	**LAYOUT** Layout consideration for flexible manufacturing Scheduling of flexiblemanufacturing system.	**6**
7	**FMS SIMULATION:** FMS simulation, Latest trends and Case studies	**6**

Course Outcomes:	
1	Identify the work systems where the FMS technology can be used
2	Identify the different types of flexibilities that exist in a given work environment and how they can be used.
3	Make a schedule for FMS for minimum make span

Bibliography:

S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	"Automation, Production System & CIM" Groover, M. P., Ed.,Prentice Hall.	2013
2	"Handbook of Flexible Manufacturing systems"Nand Kumar Jha	1991
3	"Design and Operations of FMS",Rankey, P., North-Holland Publishing.	1983
4	"Flexible Manufacturing System", Warnecke, H. J. (Ed.), Springer.	1985
5	"FMS in Practice", Bonetto, R., North Oxford Academic Publishers.	1988

Course Name	**:**	**CONCURRENT ENGINEERING**
Course Code	**:**	**PR4104**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	At the end of course, students should be able to understand the importance, concept, tools and techniques of concurrent engineering.
2	At the end of course, students should be able to lean geometric and feature based modelling

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of lectures**
1.	**INTRODUCTION** Concurrent Engineering Concepts, Sequential Versus Concurrent Engineering, Importance Of Concurrent Engineering, Benefits Of Concurrent Engineering.	**8**
2.	**DESIGN FOR MANUFACTURING AND ASSEMBLY** Mathematical Modelling Between Design And Manufacturing, Design For Manufacturing And Assembly Approach, Concurrent Product Design, Material Balance Equation, Cost Equation, Average Manufacturing Lead Time.	**13**
3.	**DESIGN METHODOLOGY** Design For X, Design Of Experiments And Taguchi's Method, Group Technology Based Design, Design For Quality, Pseudo Measure Of Product Optimality, Quality Function Deployment, Improvement In Unit Cost And Quality Of Manufactured Products.	**8**
4.	**COMPUTER AIDED ENGINEERING ANALYSIS AND PROTOTYPING** Geometric Modelling, Feature Based Design, Product Data Exchange, Prototyping, Finite Element Modelling And Analysis, Optimization.	**5**
5.	**IMPLEMENTATION AND CASE STUDIES** Difficulties Associated With Performing Concurrent Engineering, Life Cycle Costing, And Case Studies.	**8**

Course Outcomes:	
1	Formulate a design mathematically.
2	Understand the design for assembly approach using concurrent product design.
3	Able to design an industrial part and hence product using suitable CAD software.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication
1	"Product Design for Manufacture and Assembly, Third Edition", Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, CRC Press.	2010
2	"Manufacturing Design, Production, Automation and Integration", Benhabib, B., CRC Press	2003
3	"Product Design for Manufacture and Assembly", Boothroyd, G., Dewhurst, P., and Knight,	2002

Course Name	**:**	**MATERIALS MANAGEMENT**
Course Code	**:**	**PR4105**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:	
1	By the end of this course, the student will be able to describe about the material management tools.
2	By the end of this course, the student will be able learn about various inventory management tools and operating policies.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTEGRATED APPROACH TO MATERIALS MANAGEMENT** Introduction, Materials Productivity and Role of Materials Management Techniques in Improved Materials Productivity. Cost Reduction And Value Improvement, Value Analysis For Right Choice And Rationalization Of Materials.	**4**
2.	**PURCHASING FUNCTION** Objectives, Purchase Requisitions, Types of Specification, Centralized Versus Decentralized Purchasing, Timing of Purchases. Purchasing Research, Identification of Right Sources of Supplies. Make or Buy Decisions, Vender Selection and Vender Rating. Negotiations, Purchase Price Analysis and Price Determination. Purchasing Organization, Procedures, Forms, Records and Reports. Purchasing As A Dynamic Profession, Transition To Supply Management, Reverse Auctioning	**8**
3.	**INVENTORY MANAGEMENT** Inventory Concepts, Reasons for Holding Inventory, Types of Inventory, Inventory Reduction Tactics. Inventory Turnover Ratio. Selective Inventory Management: ABC, VED, And FSN Analysis Etc., Identifying Critical Items with Selective Inventory Management.	**6**
4.	**OPERATING POLICIES** Continuous Review System, Periodic Review System, Comparative Advantages and Disadvantages of Continuous and Periodic Review Systems, Hybrid Systems. Inventory Management Across the Organization.	**6**
5.	**OPTIMIZING INVENTORY** Assumptions For Wilson's Lot Size Model, Inventory Costs, Hidden Costs, Composition Of Costs, Estimation Of Inventory Related Costs, Lead Time, Stock Out Point, Number Of Time Periods, Calculating Economic Order Quantity (EOQ), Sensitivity Analysis Of EOQ Model.	**6**
6.	**SPECIAL INVENTORY MODELS** Finite Replenishment Rate Model, Lot Size Models with Planned Backlogging, Generalized Model with Uniform Replenishment Rate, Inventory Model with Lost Sales, Quantity Discount Model, One Period Decisions. Determination of Safety Stock, Service Level and Uncertainty in Demand. Information Systems For Inventory Management.	**6**

7.	**STORES MANAGEMENT** Introduction, Stores Functions, Stores Organization, Stores Systems and Procedures, Stores Accounting and Verification Systems, Stores Address Systems, Stores Location and Layout, Store Equipment. Discussion On Modern Materials Management Techniques Like JIT, SMED, DBR & MRP.	**6**

Course Outcome:	
1	Describe the inventory control and management.
2	Describe about the material management techniques

Bibliography:

S. No.	**Name of Book/Author/ Publisher**	**Year of Publication**
1	"Introduction to Materials Management", Arnold and Chapman, Fourth Edition, Pearson Education Asia	2001
2	"Production Planning & Inventory Control", Narsimhan, Mcleavey&Billington, Second Edition, Prentice Hall of India	2003
3	"Purchasing and Inventory Control", Menon K S, Third Edition, Wheeler Publishing New Delhi	1997

Course Name	**:**	**MANUFACTURING PROCESSES**
Course Code	**:**	**PR5002**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:	
1	The student shall be exposed to basic manufacturing techniques such as Metal Casting, Forming, Welding and Powder metallurgy.
2	The students will be able to understand the principles of some non-conventional machining processes and their applications.

Total Number of Lectures – 42

S. No.	**Course Content**	**Number of Lectures**
1.	**INTRODUCTION TO METALLURGY & HEAT TREATMENT** Crystal Structure, Iron Carbon Diagram, Principles of Phase Transformations, Phase Rule, Recrystallization and Grain Growth. Principles & Applications of: Annealing, Normalizing, Hardening, Tempering, Surface Hardening of Steels	**4**
2.	**CASTING** Types of Pattern, Pattern Allowances, Pattern Design, Gating Systems, Types of risers and their functions, Sand and Machine Moulding. Introduction to advanced casting processes such as: Shell Moulding, Investment Casting, Centrifugal and Pressure Die-Casting. Various Casting Defects, its causes and remedies. Introduction to Powder Metallurgy and its applications.	**8**
3.	**FORMING** Introduction, Classification, Hot And Cold Working Processes, True Strain Curves, Determination Of Flow Stress. Rolling: Classification Of Rolling Processes, Rolling Mills, Products, Variables, Rolling Defects And Controls. Defects & Remedies. Drawing: Drawing Of Rods, Wires, Tubes, Variables In Drawing And Operations. Forging**:** Open And Closed Forging, Hammer, Press And Drop Forging, Defects and Remedies. Extrusion: Classification Of Extrusion Processes, Equipment And Variables Used In Extrusion. Defects & Remedies	**10**
4.	**WELDING** Classification Of Welding Processes, Physics Of Arc, Arc Blow, Welding Symbol, Types Of V-I Characteristics, Different Types Of Power Sources, Classification and Selection of Welding Electrodes, Welding Fluxes, Different welding processes: SMAW,MIG,TIG,SAW, Resistance and electro-slag welding	**6**
5.	**MACHINING** Classification of M/c Processes, Kinds of Motions in M/c tools, Tool materials & Cutting fluids. Classification Of Lathes, Capstan And Turret Lathes, Geometry Of A Single Point Cutting Tool; Effect Of Different Angles And Cutting Parameters. Lathe Operations Such As: Facing, Tapering Parting, Chamfering, Threading, Knurling And Calculations On Machining Times. Learning the introduction and applications of Milling,	**8**

	shaping, drilling, grinding and other machines.	
6.	**NON CONVENTIONAL MACHINING PROCESSES** Classifications, Applications And Limitations. Principle And Applications Of: Abrasive Jet, Water Jet, Ultrasonic Machining, Electro-Chemical M/C, Electric Discharge M/C, Electron Beam M/C and Laser Beam M/C.	**6**

S. No.	Lists of Experiments	Number of Hours
1	Practical exercise on Metal Casting (Foundary)	**2**
2	Practical exercise on Metal Forming (Forging/wire drawing)	**2**
3	Practical exercise on Machining (Turning/Milling/Drilling)	**4**
4	Practical exercise on Welding (MMAW/GMAW/SAW)	**2**
5	Practical exposure to CNC Machining	**2**
6	Practical exposure to Advanced Manufacturing Processes (EDM/LBM)	**2**

Course Outcome:	
1	To select the suitable casting process
2	Understand the principles of metal cutting and calculate the machining time for a given job.
3	Understand different types of forming processes and identify its applications.
4	Able to learn the specific welding applications and its innovations.

Bibliography:

S. No.	Name of Book/Author/ Publisher	Year of Publication
1	"Materials and Processes In Manufacturing", John Wiley & Sons, DeGarmo	2011
2	"Modern Machining Process", P C Pandey & H S Shan, Tata McGraw Hill	2008
3	"Principle of introduction to physical metallurgy", Avner, McGraw Hill.	2012
4	"Welding Engineering and Technology", RS Parmar, Khanna Publisher	2013