M. TECH.

MANUFACTURING TECHNOLOGY

SYLLABUS

FOR

CREDIT BASED CURRICULUM

DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

AGARTALA – 799046, INDIA

M. Tech: Manufacturing Technology (Syllabus Structure)

Program: M.Tech. Manufacturing Technology					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
First Semester					
1		Physics of Manufacturing Processes	4	3-1-0	100
2		Numerical Analysis and Computer Programming	4	3-1-0	100
3		Advanced Material and Processing	4	3-1-0	100
4		Elective I	4	3-1-0	100
5		Elective II	4	3-1-0	100
6		CAD/CAM Laboratory	2	0-0-3	100
7		Welding Laboratory	2	0-0-3	100
8		Technical Writing and Seminar	1	0-0-2	100
	Total		25	28	800
Second Semester					
1		Machining Science	4	3-1-0	100
2		Non-Conventional Machining Processes	4	3-1-0	100
3		Elective III	4	3-1-0	100
4		Elective IV	4	3-1-0	100
5		Robotics and Mechatronics Laboratory	2	0-0-3	100
6		Non Traditional Machining Laboratory	2	0-0-3	100
7		Project Preliminary	3	0-0-6	100
8		Comprehensive Viva Voce	2	0-0-0	100
	Total		25	28	800
Third Semester					
1		Project and Thesis – 1	10	0-0-0	100
Fourth Semester					
1		Project and Thesis – 2	20	0-0-0	300
		Total Credit	80	Total Marks	2000

Electives (M.Tech. Manufacturing Technology)					
Elective I					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Metal Casting	4	3-1-0	100
2		Laser Technology	4	3-1-0	100
Elective II					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Production Planning and Control	4	3-1-0	100
2		Quality Systems Engineering	4	3-1-0	100
3		Supply Chain Management	4	3-1-0	100
4		Advanced Optimization Techniques	4	3-1-0	100
Elective III					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Product Design & Development	4	3-1-0	100
2		Additive Manufacturing Technology	4	3-1-0	100
3		Modeling and Simulation of Manufacturing Processes	4	3-1-0	100
4		Welding Technology	4	3-1-0	100
Elective IV					
Sl. No.	Course Code	Subject	Credit	Class hours per week	Marks
1		Metal Cutting	4	3-1-0	100
2		Machine Tool Design	4	3-1-0	100
3		Ergonomics and Industrial Manufacturing	4	3-1-0	100
4		Robotics	4	3-1-0	100

PROGRAMME OUTCOMES (POs)

Manufacturing Technology post graduate students will have

PO1 : An ability to independently carry out research /investigation and development work to solve practical problems of Manufacturing Technology.

PO2 : An ability to write and present a substantial technical report/document

PO3 : Students should be able to demonstrate a degree of mastery in the area of Manufacturing Technology. The mastery should be at a level higher than the requirements in the bachelor program of Mechanical Engineering

PO4: An ability to use research-based knowledge viz identification, analysis and interpretation for solution of problems related to manufacturing field.

PO5: An ability to apply the acquired knowledge to design / develop mechanical equipment and systems considering environmental, socio-economic and ethical issues.

PO6: An ability to contribute significantly towards elucidation of industrial problems in the domain of manufacturing technology.

PROGRAMS SPECIFIC OUTCOMES (PSOs)

PSO1: Manufacturing Technology Post Graduate Students will have competency in conventional / advanced manufacturing domain.

PSO2: Develop research attitude towards interdisciplinary and integrated approach to cater the need of manufacturing environment.

FIRST SEMESTER
PHYSICS OF MANUFACTURING PROCESSES

Semester: 1st	Credit: 4					
Course code and Name: Physics of Manufacturing Processes	**L**	**T**	**P**	3	1	0

Course Objectives:

1) The main objective of this course is to emphasize the importance of manufacturing sciences in day-to-day life, and to study the basic manufacturing processes from the point of view of underlying physics.
2) The course is designed to help students understand traditional manufacturing processes such as rolling, wire drawing, extrusion, forging, and machining.

Syllabus Content

Module 1:

Introduction of manufacturing processes from the point of view of underlying physics. Stresses and Strain: stress and strain behavior of materials, plastic and tangent modulus, work hardening, plastic instability in tensile test, empirical stress-strain equations, effect of pressure, strain-rate and temperature, analysis of stress tensor, eigen values, decomposition into deviatoric and hydrostatic components, octahedral stresses, analysis of strain and strain rates, stress equilibrium and virtual work, objective stress rates.

Module 2:

Plasticity: the criteria of yielding, isotropic and anisotropic hardening, rules of plastic flow,Levy-Mises and Prandtle-Reuss equations, anisotropic flow rule, Hill's 1948 and 1979 yield

criteria for anisotropic yielding.

Module 3:

Upper bound theorem and its application in processes like rolling, wire drawing, extrusion, forging and machining. Lower bound theorem with a few applications. Slab method and its application in process like asymmetric rolling, forging, wire drawing andextrusion.

Module 4:

Elastoplastic sheet bending and analysis of auto frettaging.

Module 5:

Theory of slipline field and its application in metal forming and machining. Heat transfer analysis in manufacturing. Workability and dynamic materials model.

Text Books:

i) Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.

ii) Physical Metallurgy by Dieter.

iii) Manufacturing Technology by P.N. Rao., MCGRAW HILL INDIA.

iv) "Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.

v) J. Chakrabarty, Theory of plasticity, Elsevier Butterworth-Heinemann Company, Singapore, 2006.

Reference Books:

i) "Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi.

ii) SeropeKalpakjian, Manufacturing engineering and Technology, Edition III - Addision-Wesley Publishing Co., 1995.

iii) Manufacturing Processes by Kaushish, PHI.

iv) “Introduction to Manufacturing Processes” by Schey J

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	To understand the basic mechanisms of manufacturing processes & implement various material testing methods for detection of surface & subsurface defects and mechanical properties.	1
2	To understand the plasticity phenomenon of materials & Levy-Mises and Prandtle-Reuss equations.	2
3	To Understand and analyze upper and lower bounds theorems, as well as their applications in rolling, wire drawing, extrusion, forging, and machining operations.	3
4	To understand the method for increasing the fatigue strength of components for use at high and pulsating pressures & linear incremental stress strain relations for strain hardening.	1,4
5	To understand and analyze the heat transfer characteristics in manufacturing processes & the physics of the slipline field and how it's used in metal forming and machining.	5

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	3	2	3	2	2	1	2
CO-2	2	1	3	1	2	1	2	1
CO-3	3	2	2	2	2	3	2	2
CO-4	3	2	3	2	2	2	1	2
CO-5	2	3	2	3	2	2	2	2

NUMERICAL ANALYSIS AND COMPUTER PROGRAMMING

Semester: 1st	**Credit:** 4					
Course Code and Name: Numerical Analysis and Computer Programming	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To be familiar with numerical solution of equations.
2) To get exposed to finite differences and interpolation.
3) To be through with the numerical Differentiation and integration.
4) To find numerical solutions of ordinary differential equation.
5) To find numerical solutions of partial differential equation.

Syllabus Content

Module 1:

Approximation and round off errors; Truncation errors and Taylor series. Determination of roots of polynomials and transcendental equations by Newton- Raphson, Secant and Barstow's method. Solution of linear simultaneous algebraic equations by Gauss elimination and Gauss-Siedel iteration methods.

Module 2:

Curve fitting; Linear and non-linear regression analysis. Finite Difference Method: Backward; Forward and central difference relations and their uses in numerical differentiation and integration; Application of different relations in the solution of partial differential equations, Introduction of Finite Element Method. Numerical solution of ordinary differential equations by Euler; modified Euler, Runge-Kutta and predictor-corrector method.

Module 3:

Introduction to computer programming in C and C++ languages: Arithmetic expressions; Simple programs Example of some C programs; Dissection of the program line by line; Concept of variables; Program statement and function calls from the library. C datatypes: int, char, float etc.

C expressions, arithmetic operations, relational and logic operations.

Module 4:

C assignment statements, extension of assignment to the operation; C primitive input output using getchar and putchar; exposure to the scanf and printf function.C statements; conditional execution using if, else etc.(Optionally switch and break statements should be mentioned)

Module 5:

Concepts of loop; Example of loops in C using for-while and do-while(Optionally continue may be mentioned). One dimensional arrays and example of iterative programs using arrays; 2-d arrays; Use in matrix computations.

Module 6:

Concept of sub-programming; Functions; Example of functions; Argument passing mainly for the simple variables. Pointers, relationship between arrays and pointers; Argument passing using pointers. Array of pointer; Passing arrays as arguments. Strings and C string library. Structure and unions; Defining C structure; Passing structure as arguments (Programexamples) File I/O; Use of fopen, fsanf and fprintf routines.

Text Books:

i) C.Xavier: C Language and Numerical Methods.
ii) Dutta& Jana: Introductory Numerical Analysis.
iii) J.B.Scarborough: Numerical Mathematical Analysis.
iv) Jain, Iyengar ,& Jain: Numerical Methods (Problems and Solution).

Reference Books:

i) Balagurusamy: Numerical Methods, Scitech.
ii) Baburam: Numerical Methods, Pearson Education.
iii) N. Dutta: Computer Programming & Numerical Analysis, Universities Press

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	An ability to apply knowledge of mathematics, science, and engineering. An ability to design and conduct experiments, as well as to analyze and interpret data.	1,2
2	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. An ability to function on multidisciplinary teams.	2.3
3	An ability to identify, formulates, and solves engineering problems. An understanding of professional and ethical responsibility	3,4
4	An ability to communicate effectively. The broad education necessary to understand the impact of engineering solutions in global, economic, environmental, and societal context.	4,5
5	Recognition of the need for, and an ability to engage in life-long learning. Knowledge of contemporary issues. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	5,6

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	2	2	1	1	1	1	2
CO-2	1	2	1	2	2	2	2	2
CO-3	2	1	2	3	3	3	2	1
CO-4	1	2	1	2	2	3	1	2
CO-5	2	2	2	3	3	2	2	2

ADVANCED MATERIALS & PROCESSING

Semester: 1st	Credit: 4					
Course code and Name: Advanced Materials and Processing	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To familiarize with the knowledge of different advanced materials
2) To study different manufacturing processes of advanced materials
3) To study the importance of advanced materials and their applications in engineering field

Syllabus Content

Module1:

Introduction of advanced materials and its manufacturing processes for engineering applications.

Module2:

Piezoelectric materials (PZT): piezoelectric effect, Di-electric hysterisis, piezoelectric constants, piezoelectric charge constants, dynamic behaviour of PZT transducers, piezoelectric materials and manufacturing techniques (stability, poling and depolarisation).

Module3:

Shape memory alloys (SMA): Shape memory effect and the metallurgical phenomenon of SMA, Temperature assisted shape memory effect, Visco-elastic behaviour, magnetic shape memory effect. Various shape memory alloys. Manufacturing technology of SMAs.

Module4:

Electro rheological (ER) and magneto-rheological (MR) materials: Characteristics of ER and EM fluids. ER and EM materials.

Module5:

Composite materials: Design and manufacturing of polymer matrix, metal matrix and ceramic matrix composites. Various forms and type of reinforcements, fillers and additives. Design of composites for structural, wear resistance and high temperature applications. Micro-electromechanical (MEMS) systems. Introduction, characteristics of silicon wafers and other materials for MEMS applications.

Module6:

Various manufacturing techniques of MEMS components Materials for high temperature applications: Ni-Cr alloys, ODS materials, Ni base and Co based super alloys, carbon-carbon composites. Diffusion bond coating of high temperature materials.

Module7:

Powder metallurgy: Introduction and feature of powder metallurgy processes. Advanced solidification techniques: directional solidification, single crystal growth and levitation melting.

TextBooks:

i) Gandhi, M.V., Thompson, B.S., Smart Materials and Structures, Chapman and Hall
ii) Ray, A.K. (ed), Advanced Materials, Allied publishers.
iii) Rama Rao, P. (ed), Advances in Materials and their applications, Wiley Eastern Ltd.

ReferenceBooks:

i) R. E. Smallman, A. H.W. Ngan**,** Physical Metallurgy and Advanced Materials, Butterworth-Heinemann (Elsevier)
ii) Milton Ohring, Engineering Materials Science, Academic Press
iii) Smart Materials, Edited by Mel Schwartz, CRC Press
iv) Shape Memory Alloys, Edited By Dimitris C. Lagoudas, Springer Publications
v) James K. Wessel, Handbook of advanced materials, Wiley Online Library

CourseOutcomes

CO-No.	Course Outcome	Module Covered
1	Provide and understanding about advanced materials and their applications in engineering field.	1
2	Develop a knowledge about advanced materials such as piezoelectric materials, shape memory alloys, ER, MR and composites and their manufacturing techniques and applications	2, 3, 4, 5
3	Design materials for different engineering applications	2, 5
4	Develop a knowledge about materials and their manufacturing techniques for MEMS applications	5, 6
5	Develop a knowledge on coating of high temperature materials, powder metallurgy process and advanced solidification techniques	6, 7

CO-PO Mapping (Rate: scaleof1 to3)

CourseOutcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	3	1	1	2	2	2
CO-2	1	2	3	2	2	2	2	3
CO-3	2	2	3	2	2	2	2	3
CO-4	2	2	3	1	2	2	3	2
CO-5	2	2	3	1	2	2	1	2

CAD/CAM LABORATORY

Semester: 1st	Credit: 2					
Course Name: CAD/CAM Laboratory	**L**	**T**	**P**	0	0	3

Course Objectives:

1) To create and manipulate geometric models using curves, surfaces and solids.
2) To create CNC Program for machining automotive engineering and machine tool engineering components.

List of Experiments

Exp 1 : Construction of 3D models of Machine Tool Components.

Exp 2 : Construction of 3D models of automotive engineering components.

Exp 3 : Construction of 3D assembly of machine tool and automotive engineering components.

Exp 4 : Preparation of drafting sheet for parts and assembly along with GD&T.

Exp 5 : Import and Export of CAD data. (IGES, STEP, Parasolid, STL, etc.)

Exp 6 : Preparation and Simulation of CAM program for CNC Milling Machine.

Exp 7 : Machining of Complex Profile using CNC Milling Machine

Exp 8 : Preparation and Simulation of CAM program for CNC Lathe Machine

Exp 9 : Machining of Complex Profile using CNC Lathe Machine

Exp 10 : Export of ready-to-run CNC-programs with no need for manual editing.

Course Outcomes:

At the end of this course, students will be able to

CO-No.	Course Outcome	Exp
1	Create 3D geometric models using Solid Works graphical software	1,2,5
2	Create 3D assembly drawing using Solid Works graphical software	3,5
3	Preparation of drafting sheet for Parts and Assembly along with GD&T.	4
4	Create Programs, simulate and to machine complex profile using CNC Machines	6,7,8,9
5	Generate codes using CAM Softwares	10

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	**3**			**2**	**-**	**2**	**3**	**-**
CO-2	**3**			**-**	**-**	**2**	**3**	**-**
CO-3		**3**		**-**	**-**	**2**	**3**	**-**
CO-4		**3**		**-**	**-**	**2**	**3**	**-**
CO-5			**3**	**-**	**-**	**2**	**3**	**-**

WELDING LABORATORY

Semester: 1st	Credit: 2					
Course Name: Welding Laboratory	**L**	**T**	**P**	0	0	3

Course Objectives:

1) This Laboratory course is designed to make the student understand and demonstrate the various types of welding processes and their variables, testing methods and correlation between micro structure and mechanical properties of the welded joints.
2) To gain knowledge of practical aspects of different welding processes and be able to apply them for various engineering applications.

List of Experiments

Exp 1: Arc striking practice: Simple exercises to make butt, lap, fillet joints using SMAW, GMAW, FCAW and GTAW processes.

Exp 2: Studying the effect of electrode polarity on weld bead formation.

Exp 3: Effect of welding parameters on weld bead by

- ❖ GTA welding
- ❖ GMA welding
- ❖ Submerged arc welding

Exp 4: Studying the effect of heat input on temperature distribution.

Exp 5: Studying the effect of shielding gases on weld quality

Exp 6: Evaluating the performance of Power Source Characteristics.

Exp 7: Studying the effect of welding parameters of various processes such as SMAW, GMAW, FCAW, GTAW on bead geometry

Exp 8: Studying the effect of friction stir welding parameters on weld quality

Exp 9: To evaluate the microstructure of welded joint and understand the structural difference in Weld zone, Heat Affected Zone and Base metal.

Exp 10: Studying the effect of electrical resistance welding parameters on weld nugget formation.

Course Outcomes

CO-No.	Course Outcome	Exp
1	Acquire practical knowledge on fusion and solid-state welding processes.	1,7,8
2	Select process parameters by weld bead on plate trial.	2,3
3	Understand the effect of welding parameters on quality of welded joint.	3,4

4	Gain knowledge in practical aspects of GTAW, GMAW SAW, FCAW	7
5	To understand various methods of welding and joining of metals, the mechanical behavior of the joint with respect to microstructure and mechanical properties.	9

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	2	1	1	-	2	2	1
CO-2	2	1	1	2	1	2	2	2
CO-3	2	3	2	2	2	3	2	2
CO-4	3	2	1	1	2	3	2	1
CO-5	3	2	2	3	2	2	2	2

TECHNICAL WRITING AND SEMINAR

Semester: 1st	Credit: 1					
Course Name: Technical Writing and Seminar	**L**	**T**	**P**	0	0	2

Course Objectives:

1) To inculcate the habit of performing extensive literature survey to the students.
2) To make students capable of identifying the relevant topics on which research can be carried out
3) To improve the presentation skills of the students.

Syllabus Content

Module 1: Literature survey on the topic given by teacher

Module 2: Identification of the problem/gap

Module 3: Presentation of the topic

Module 4: Submission of technical report

Course Outcomes

At the end of this course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Perform extensive literature survey on the problem / topic assigned / selected.	1
2	Identify the research gap and propose topic for future research analysis.	1,2
3	Summarize and present their findings based on literature survey.	1,2,3
4	Summarize and submit a technical report based on literature survey.	1,2,3,4

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	1	3	1	2	2	2	1
CO-2	3	2	3	2	1	2	2	2
CO-3	2	3	3	2	2	3	2	2
CO-4	1	3	3	1	2	3	2	1

SECOND SEMESTER
MACHINING SCIENCE

Semester:2nd	Credit:4					
Course Name: Machining Science	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To know about the Automation and types of Automations in the industries.

2) To understand the different Automated flow lines in the industries.

3) To perform one or more processing and /or assembly operations on a starting raw material, part, or set of parts.

4) To perform a sequence of automated or mechanized assembly operations Flexible manufacturing system (FMS)

5) To know about the robotics and its application in Automation.

Syllabus Content

Module 1:

Fundamentals of manufacturing**:** Production System Facilities, Manufacturing support systems, Different types of manufacturing systems, Automation in Production systems, ManufacturingOperations,Product, Production Relationships.

Module2:

Automation Principles & Strategies, concept of automation; types of automation; flexibility,degree, level and yardstick of automation; Components of automation: Sensors, Actuators andinputoutput devices. Group Technology, Line Balancing

Module 3:

Industrial Control: Industrial Control Systems, Mechanical, Electrical, Hydraulic, Pneumatic,electronicandhybridsystems.ConceptsfeaturesparametersgoverningtheSelectionofvariouscomponentsNecessaryfor Building theelements.

Module 4:

Fundamentals of Production Lines, Types of Assembly Lines, Transfer Devices and machines,Feedersand its classification, Parts feeding Devices.Average production time and production rate; Line efficiency; Analysis of transfer lines; Design for automated assembly; Transfer systems; Vibratory bowl feeders – its analysis; Nonvibratory feeders and their analysis; Analysis and design of part orienting devices, feed tracks and part placing mechanisms.

Module 5:

PLC: Discrete Control using PLC & PLC network, Introduction, Micro PLC, Programming a PLC, Logic Functions, input & output Modules.

Module 6:

Robot I/O interfacing will be discussed including interfacing to sensors and end effectors. Robotprogramming using a teach pendant will be cover including applications for; pick and

place,dispensing,decision making, machine tending, andpalletizing of product.

TextBooks:

i) Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.

ii) Industrial Automation: W.P. David, John Wiley and Sons.

iii) Handbook of design, manufacturing & Automation: R.C. Dorf, JohnWileyand Sons.

ReferenceBooks:

i) NickDawkins-AutomationandControls

ii) Peter G.Martin and Gregory Hale-Automation Made Easy

iii) A.K. Gupta, S. K. Arora- Industrial Automation and Robotics

CourseOutcomes

CO-No.	Course Outcome	Module Covered
1	Illustratethebasic conceptsofautomationinmachinetools.	1,2
2	Analyze various automated flow lines, explain assembly systems and line balancing methods.	2,4
3	Describetheimportance ofautomatedmaterialhandlingandstorage Systems.	3,4
4	Knowledge about various components of automation like sensors, actuators, PLC.	2,5
5	Interprettheimportance ofadaptivecontrolsystems,automatedin section systemsby using robots.	6

CO-POMapping(Rate: scaleof1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	2	2	1	1	1	2	1
CO-2	2	2	2	3	3	3	2	2
CO-3	2	2	2	2	3	3	2	1
CO-4	2	2	2	2	3	3	2	1
CO-5	2	2	2	2	3	3	2	2

NON-CONVENTIONAL MACHINING PROCESSES

Semester: 2nd	Credit: 4					
Course Name: Non-Conventional Machining Processes	**L**	**T**	**P**	3	1	0

Course Objectives:

1) The objective of this course is to provide the students the knowledge of modern manufacturing processes such as Ultrasonic machining, Abrasive machining processes, Electrochemical machining, Electro discharge machining etc.& their modifications into hybrid processes.
2) To learn advanced topics such as Laser beam welding/machining, Electron beam welding/machining & state of art in various research areas.

Syllabus Content

Module 1:

New Technology, Introduction, Mechanical Processes, Abrasive jet Technology, Ultrasonic machining, whirling jet machining. undamental principles, process parameters, characteristics, Tool design, Metal removal rate-analysis, important part design, Analysis of the Process.

Module 2:

Chemical and Electro-chemical machining –Introduction. Principles & scheme, Process parameters, metal removal rate, dynamic and hydro-dynamic & hydro-optimization,electrolytes.

Module 3:

EDM: Introduction-basic principles & scheme, circuitry controls, metal removal rate, machining accuracy, optimization, selection of tool material and tool design, Di-electric, Analysis.

Module 4:

Laser Beam Machining & Electron beam machining back ground, production of Laser, machining by Laser and other applications, Electron beam action, Dimensionless analysis to establish correlation, behavior EBM parameters. High Velocity forming of metals, explosive forming principles and applications, Electro-hydraulic and other applications, Analysis of the process.

Text Books:

i) Manufacturing science by Ghosh and Mallick.
ii) “Advanced Machining Processes” V.K. Jain, Allied Publishers Pvt. Ltd.
iii) Modern machining process Pandey and Shah TATA McGraw Hill 2000.
iv) Unconventional Manufacturing process M K Singh New age publications ISBN 978-81- 224-2244-3.

Reference Books:

i) Production Technology HMT TATA McGraw Hill – 2001

ii) Thermal Metal cutting processes B G Ranganath I K International Publishing house Pvt. Ltd.

iii) Non traditional machining by P.K Mishra.

iv) Benedict. G.F. "Nontraditional Manufacturing Processes", Marcel Dekker Inc., New York,1987.

v) McGeough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.

vi) Fundamentals of Machining and Machine Tools R.K.Singal I K International Publishing house Pvt. Ltd

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	To categorize different material removal and joining processes as per the requirements of the material being used to manufacture the end product.	1
2	To select material processing techniques with the aim of cost reduction, reducing material wastage & machining time.	2
3	To implement water energy, electro-magnetic, electro-discharge and explosive energy for the forming process and the high energy beam for the welding process.	3
4	Identifying the process parameters influencing product quality in various advanced metals, nonmetals, ceramics, and composites machining.	2,4
5	Different processes are hybridized in order to produce high-quality products.Merits and demerits of different processes.	1,2,4

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	2	2	2	1	2	1	2
CO-2	2	2	1	3	2	2	2	3
CO-3	2	1	2	2	1	2	1	2
CO-4	2	2	1	2	2	3	2	2
CO-5	3	2	2	1	1	2	2	1

ROBOTICS AND MECHATRONICS LABORATORY

Semester: 2nd	Credit: 2					
Course Name: Robotics and Mechatronics Laboratory	**L**	**T**	**P**	0	0	3

Course Objectives:

1) To impart basic knowledge and importance on Robotics and Mechatronics in Engineering Fields among the students.
2) To create the awareness on Robotics and Mechatronics in Research and Application area.

List of Experiments

Exp 1: To Study Robot motion in Cartesian, cylindrical and spherical co-ordinate system.
Exp 2: To study the pick and place motion on five axes robot.
Exp 3: Study of making a program on Labview with Push Button and Round LED.
Exp 4: Study of making a program on Labview with Loop and Logical function.
Exp 5: Study of making a program on Labview for Sound Accusation and again play.
Exp 6: Study of making a program on Labview for Comparison.
Exp 7: Study of making a program on Labview for power control of a DC motor.
Exp 8: Study of making a program on Labview for Temperature Acquisition.
Exp 9: Study of making a program on Labview for Voltage Acquisition.
Exp 10: Study of making a program on Labview for Current Acquisition.

Course Outcomes

CO-No.	Course Outcome	Exp
1	Robot motion in cartesian, cylindrical and spherical co-ordinate system.	1
2	Programming and control of five axis robots.	2
3	Programming for sound, temperature, voltage and current acquisition.	5,8,9,10
4	Programming for comparison and power control of DC motor.	6,7
5	Following features in Lab view software: While Loops, Plotting, SubVIs, Case Structures, Arrays, Clusters	4
6	Knowledge will be gained on application and utility of Robotics and Mechatronics used in various sectors and fields.	1-10

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	2	2	3	3	3	3
CO-2	2	2	2	3	3	2	3	3
CO-3	3	2	3	2	3	3	3	3
CO-4	2	2	2	3	3	2	3	3
CO-5	2	2	2	2	3	3	3	3
CO-6	2	2	3	3	3	2	3	3

NON-TRADITIONAL MACHINING LABORATORY

Semester: 2nd	Credit: 3					
Course Name: Non Traditional Machining Laboratory	**L**	**T**	**P**	0	0	3

Course Objectives:

1) Acquire a functional understanding of non-traditional machining processes.
2) Know about various process parameters and their influence on performance and their applications.
3) Understand the terminology used in non-traditional manufacturing industries.

List of Experiments

Exp 1: To study die sinking EDM and wire cut EDM.

Exp 2: To study Ultra-sonic machining process.

Exp 3: To study Plasma arc machining process.

Exp 4: To study of Electrochemical machining process.

Exp 5: To study of Chemical Machining process.

Exp 6: To study experiment onHigh-Energy-Beam Machining

– Laser-beam machining (LBM)

– Electron-beam machining (EBM)

Exp 7: To study influence of process parameters in Water-Jet Machining.

Exp 8: To study effect of process parameters in Abrasive-Jet Machining.

Course Outcomes

CO-No.	Course Outcome	Exp
1	Broad understanding of machining using different energy sources.	1,6
2	Understand the concept of machining the hard material using chemical energy and electrochemical energy.	4,5
3	Able to implement the mechanical energy, chemical, water and electrochemical based unconventional machining process.	4,5,7
4	To identify the process parameters affecting the product quality in various advanced machining	6,7,8
5	Able to think about the possibility of combining different processes to develop a more efficient machining process.	1,2,3,5,6,7

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	1	2	1	2	1	1
CO-2	3	2	1	1	2	2	2	-
CO-3	2	3	2	2	1	3	2	2
CO-4	3	2	2	2	1	2	2	2
CO-5	3	2	1	2	1	2	2	2

COMPREHENSIVE VIVA

Semester: 2nd	Credit: 4					
Course Name: Comprehensive Viva	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To assess the overall knowledge of the student in the field of Manufacturing Technology acquired over one year of study in post graduate program.

Course Outcomes

At the end of the course, students will be able to

CO-No.	Course Outcome
1	Comprehend any given problem / concept related to Manufacturing Technology domain.
2	Recall, recognize, visualize, demonstrate, criticize and appraise the concepts related to Manufacturing Technology domain.

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	1	3	1	2	2	2	1
CO-2	3	2	3	2	1	2	2	2

PROJECT PRELIMINARY

Semester: 2nd	Credit: 6					
Course Name: Project Preliminary	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To provide the opportunities to the student to demonstrate and develop concept/project in the respective Engineering Domain
2) To enable a student to work in cutting edge research problems in harmony.
3) To inculcate the practice of carrying research with ethics and safety.

Course Outcomes

CO-No.	Course Outcome
1	Undergo literature survey in the chosen field of research
2	Approach and identify a research problem and able to analyze the scope of research
3	Develop a research methodology to proceed with the research
4	Summarize and Present a technical presentation with proper reference

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	1	3	1	2	2	2	1
CO-2	3	1	3	2	1	2	2	2
CO-3	3	3	3	2	2	3	2	2
CO-4	1	3	3	1	2	3	2	1

THIRD SEMESTER
PROJECT AND THESIS-I

Semester: 3rd	Credit: 12					
Course Name: Project and Thesis – I	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To provide the opportunities to the student to demonstrate and develop concept/project in the respective Engineering Domain
2) To enable a student to work in cutting edge research problems in harmony.
3) To inculcate the practice of carrying research with ethics and safety.

Course Outcomes

CO-No.	Course Outcome
1	Intensive literature survey and identify the research problems related to Material Science and Engineering.
2	Communicate and discuss research ideas
3	Develop a systematic model/approach to analyze and solve the research problems.
4	Outline the past, present and expected outcome based on systematic survey.
5	Conduct preliminary experiments / theoretical evaluation to certain extent.
6	Summarize their survey, research problem identification, approach, ,expected outcome and attained results with interpretation by means of oral presentation and written reports

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	**3**	**-**	**3**	**1**		**2**	**1**	**2**
CO-2	**3**	**2**	**3**	**1**	**2**	**1**	**1**	**1**
CO-3	**3**		**3**	**2**	**3**	**2**	**2**	**2**
CO-4	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**1**
CO-5	**3**		**3**	**1**	**2**		**1**	**1**
CO-6	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**2**

FOURTH SEMESTER
PROJECT AND THESIS-II

Semester: 4th	Credit: 20					
Course Name: Project and Thesis-II	**L**	**T**	**P**	0	0	0

Course Objectives:

1) To provide the opportunities to the student to demonstrate and develop concept/project in the respective Engineering Domain
2) To enable a student to work in cutting edge research problems in harmony.
3) To inculcate the practice of carrying research with ethics and safety.

Course Outcomes

CO-No.	Course Outcome
1	Survey, approach, identify and demonstrate the research / industrial problems using various available modern tools and techniques
2	Develop and validate a systematic model/processto analyze and solve the research problems.
3	Outline the past, present and expected performance / outcome of a material / product / process / model / system(s) in Engineering domain in confirmation to the standard of safety and environmental, economicand ethical yardstick.
4	Conduct experiments and theoretical evaluation extensively
5	Analyze, summarize, inferbased on extensive research and communicate their chosen domain problems and result optimistically by means of oral presentation and written dissertation reports
6	Present and publish their findings as technical manuscript in technical conference/ indexed research journals ethically.

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**2**
CO-2	**3**	**2**	**3**	**2**	**2**	**1**	**1**	**1**
CO-3	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**
CO-4	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**	**1**	**3**	**2**
CO-6	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**

ELECTIVE- I
METAL CASTING

Semester: 1st	Credit: 4					
Course Name: Metal Casting	**L**	**T**	**P**	**3**	**1**	**0**

Course Objectives:

1) To learn about silica, clay and sand.
2) To learn about metal solidification and super cooling.
3) To learn freezing of alloys centerline and metals fluidity.
4) To learn about riser design and effective feeding distances for simple and complex shapes.
5) To learn about gas aspiration and metal penetration.
6) To learn fabrication of casting process and non-ferrous die casting.

Syllabus Content

Module 1:

Structure of silica and different types of clays, bonding mechanism of silica – water-claysystems. Swelling of clays, sintering adhesion and colloidal clay; silica grain shape and sizedistribution standard permeability A.F.S. clay.

Module 2:

Characteristics, Ingradients and additives of moulding sand, core sands .

Module 3:

Solidifications of Metals, nucleation, free energy concept, critical radius of nucleus. Nucleationand growth in metals and alloys.

Module 4:

Constitutional super cooling. Columnar equi acquiesced and dendritic structures.

Module 5:

Freezing of alloys centre line feeding resistance.

Module 6:

Rate of solidification, time of solidification, mould constant.

Module 7:

Fluidity of metals, volumes redistribution.

Module 8:

Analysis of the process. Riser design shape, size and placement. Effect of appendages on risering.

Module 9:

Effective feeding distances for simple and complex shapes. Use of chills, gating design, fillingtime.

Module 10:

Aspiration of gases. Top, bottom and inside gating. Directional solidifications stresses incastings. Metal mould reactions.

Module 11:

Expansion scale and metal penetration.

Module 12:

Analysis of the process. Various moulding and casting processes, hot box, cold box process, investment, shell moulding, full mould process, die casting, ceramic shell mould, vacuum moulding etc.

Module 13:

Non-ferrous Die-casting of Aluminium and its alloys, brass and bronze.

Text Books:

i) Fundamentals of Metal casting, Flinn, Addison Wesley.
ii) Principles of Metal casting, Heine, Loper& Rosenthal, McGraw Hill.
iii) Procuct Design and Process Engineering Practice, Niebel & Draper, Salmon& Simons, McGraw Hill Foundry, Issac Pitaman.

Course Outcomes:

At the end of this course, students will be able to

CO-No.	Course Outcome	Module Covered
1	Silica structure, classification of clay and sand	1, 2
2	Metal solidification phenomena and super cooling	3, 4, 6
3	Freezing of alloys centreline and metals fluidity	5, 7
4	Riser design and effective feeding distances for simple and complex shapes	8, 9
5	Aspiration of gases and metal penetration	10, 11
6	Fabrication of casting process and non-ferrous die casting	12, 13

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	2	3	3	3	2	3	3
CO-2	2	2	3	2	3	3	2	3
CO-3	3	2	3	3	2	2	3	3
CO-4	2	3	3	3	2	3	2	3
CO-5	3	3	2	3	3	2	3	2
CO-6	3	2	3	3	2	3	3	3

LASER TECHNOLOGY

Semester: 2nd	Credit: 4					
Course Name: Laser Technology	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To understand the fundamentals of lasers, laser systems, their characteristics and diversified applications, including in industry, medicine & defence.
2) To provide key physical concepts underlying laser and nonlinear optics and their contemporary applications with sufficient knowledge to use and understand lasers and nonlinear optical processes for research or commercial purposes.

Syllabus Content

Module 1:

Interactionof Lightwith Matter: Laser fundamentals: Spontaneous and stimulated emission, absorption,Einstein coefficients, Relation between these coefficients, Lifetime of excited state, Line Broadening mechanisms, Population inversion, Threshold condition for Laser, Laser-Rate equations for three-level and four-level systems, Conditions for CW and pulsed laser action.

Module 2:

Different Population Inversion Techniqueswith Examples: Optically pumped lasers, solid state lasers, dye lasers, electrical-discharge pumped lasers, gas lasers, chemical lasers, gas dynamic lasers, semiconductor lasers, free-electron lasers, gamma ray lasers, fiber lasers (only introductory description of these lasers).

Module 3:

Optical Resonators: General considerations, Laser resonators,General conditions of stability, Plane and spherical mirror cavities, Modes and optical resonators, Gaussian beam propagation,Theory of Q-switching and experimental methods - Theory of Mode locking and experimental methods, Frequency stabilization of laser beams, Multimode oscillation.

Module 4:

Characteristics of Laser Beams and Applications: Monochromaticity, Spatial & temporal coherence, temporal coherence &monochromaticity relation, connection between spatial coherence and directionality, rightness, Focus ability, ultra-short pulse generation. Peak Power, Average Power, Duty Cycle in Pulsed Lasers.

Module 5:

Typesof Lasers: Solid, Liquid and Gas Lasers. Brief description of Ruby, He-Ne, Nd: YAG, Nd: glass, Er:glass, Er: YAG, Carbon Dioxide Lasers, Nitrogen Lasers, Semiconductor Lasers. X-Ray Lasers, Free-electron Lasers, Fiber Lasers, Femto second Lasers, Raman Lasers.

Module 6:

Applications of Lasers: General Applications of Lasers including Industry, Defence, Medicine, Entertainment, laser cutting, machining, drilling, forming, sintering, heat treatment, alloying, cladding, marking etc.

Text Books:

i) Laser Principles, Types and Application by KR Nambiar, New Age International.
ii) Modern Spectroscopy by J Michael Hollas, Fourth Edition, John Wiley and Sons.
iii) Lasers: Theory and Applications : A K Ghatak and K Thyagarajan, McMillan, 2003.

Reference Books:

i) Lasers Theory and Applications by K. Thyagarajan and A.K. Ghatak, Mcmillan (1981).
ii) Laser Fundamentals, by William T. Silfvast, Cambridge University Press, 2008.
iii) Principles of Lasers, by Orazio Svelto; Springer, 2009.
iv) Laser Spectroscopy and Instrumentation by W. Demtroder.
v) Industrial Applications of Lasers, by K. Koebner (ed.), Wiley (1984).

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	To describe and explain fundamental concepts in laser physics.	1
2	To compare the functions and properties of a number of common lasers.	2
3	Have an understanding of phase matching, second order nonlinear processes and the key physical concepts underlying nonlinear optics.	3
4	Be able to match laser properties and laser systems to best fit application needs.	4,5
5	To know key laser applications and commercially important lasers.	6

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	1	2	1	2	2	1	2
CO-2	1	2	1	2	1	2	1	2
CO-3	3	2	2	2	1	2	2	1
CO-4	2	3	1	2	2	3	2	2
CO-5	3	2	1	3	2	3	1	2

ELECTIVE II
PRODUCTION PLANNING & CONTROL

Semester:1st	Credit:4					
Course Name: Production Planning and Control	**L**	**T**	**P**	3	1	0

CourseObjectives:

1) Understand the requirement of production planning and control for manufacturing organizations.
2) Develop skills to estimate and use appropriate planning and control techniques.
3) Ability to evaluate, analyze and make decisions for short term as well as long term organizational growth
4) To develop an ability to apply PPC concepts in a various areas like marketing, accounting, finance, engineering, personnel management, logistics, etc.
5) To understand the problems and opportunities faced by the operations manager in manufacturing and service organizations.

Syllabus Content

Module1:

INTRODUCTION: Definition – Objectives of production Planning and Control – Functions of productionplanning and control – Elements of production control – Types of production – Organizationof production planning and control department – Internal organization of department.

Module2:

FORECASTING: Importance of forecasting –Types of forecasting, their uses –General principles ofForecasting –Forecasting techniques– qualitative methods- Jury/Expert Method, Survey ofExpert opinion method , Sales force composite method, Survey of buyers intention methodand quantitative methods-Simple average, moving average, smoothing coefficient, LeastSquare method.

Module3:

INVENTORY MANAGEMENT: Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQmodel – Inventory control systems – P–Systems and Q-SystemsIntroduction to MRP-I, MRP-II & ERP, JIT inventory, Kanban system

Module4:

SCHEDULING: Definition – Activities-Difference with loading, Scheduling types: Forward, Backwardscheduling, Job shop scheduling methods – Arrival pattern, processing pattern, number of workers available, machine varieties available, Priority rules for job sequencing FIFO, SPT,SOT,

EDD, STR, CR, LISO, Random Orders. Scheduling Techniques Gantt Charts, LOB,Johnson's job sequencing rules- n jobs on 2machines, n jobs on 3 machines, n jobs on machines.

ROUTING: Definition – Routing procedure –Route sheets – Bill of material – Factors affecting routingprocedure.

Module5:

DISPATCHING: Centralized and Decentralized Dispatching- Activities of dispatcher – Dispatching procedure– follow-up – definition – Reason for existence of functions – types of follow up, applicationsof computer in production planning and control.

Module6:

MATERIALS MANAGEMENT: Materials purchasing, quotations, Rate controls; Introduction to value analysis.

TextBooks:

i) Samuel Eilon, "Elements of Production Planning and Control", Universal PublishingCorporation.
ii) Baffa&RakeshSarin , "Modern Production & Operations management", 8th edition, John Wiley.
iii) Jain K.C &Aggarwal L.N, "Production Planning and Control & Industrial Management", Khanna Publishers.

ReferenceBooks:

i) S.N. Chary, "Production & Operations Management", (4th Edition), TMH.
ii) Martin K. Starr and David W. Miller ,"Inventory Control Theory and Practice", Prentice Hall.
iii) Dr. C. Nadha Muni Reddy and Dr. K. VijayaKumarReddy "Reliability Engineering & Quality Engineering", Galgotia Publications, Pvt., Limited.
iv) S.k Sharma, savita Sharma, "A Course in Industrial Engineering and Operations Management", Tata McGraw Hill publications.

CourseOutcomes

CO-No.	Course Outcome	ModuleCovered
1	Recognize the objectives, functions, applications of PPC and forecasting techniques.	1,2
2	Explain different Inventory control techniques.	3
3	Discuss about scheduling and routing, solve routing and scheduling problems	4
4	Explain different Dispatching procedure and their applications in production planning and control	5
5	Describe way of different material purchasing techniques, rate controls.	6

CO-POMapping(Rate: scaleof1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	2	2	1	3	2	2
CO-2	2	2	2	2	1	3	2	2
CO-3	2	2	2	2	2	3	2	2
CO-4	2	2	2	2	1	3	1	1
CO-5	1	2	1	2	2	3	1	1

SUPPLY CHAIN MANAGEMENT

Semester: 1st	Credit: 4					
Course Name: Supply Chain Management	**L**	**T**	**P**	3	1	0

Course Objectives:

1. An understanding of the primary differences between logistics and supply chain management
2. An understanding of the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain
3. An understanding of the management components of supply chain management
4. An understanding of the tools and techniques useful in implementing supply chain management
5. Knowledge about the professional opportunities in supply chain management.
6. Integrate concepts and techniques learned through this course in order to design and efficient chain

Syllabus Content

Module1:

Building blocks of a supply chain network. Business processes in supply chains. Types of supply chains and examples.Strategic, tactical, and operational decisions in supply chains. Supply chain performance measures.

Module 2:

Supply chain inventory management: Traditional inventory Management –Inventory Models-Inventory Terminology, Base-stock, and (Q, R) models, multi-echelon supply chains, bullwhip effect.

Module 3:

Performance modeling of supply chains using Markov chains and queuing networks. Mathematical programming models for supply chain planning, design, and optimization.

Module 4:

Procurement & Logistics Management in Supply Chain – Introduction to Purchasing cycle –Types of Purchases, Classification of Purchase Goods & Services, History & evolution of Logistics –Elements of Logistics Management, Distribution Management, Distribution Strategies, Transportation Management, Fleet management, Containerization Ware Housing, Packing for Logistics, Third party Logistics, 4PL, Technology Components

Module 5:

Operations and Demand management in Supply chain: Introduction of Basic Principals of manufacturing Management & its System, Role of Production in Business –Mass Production systems, Lean Manufacturing Agile Manufacturing, Quick Response Manufacturing (QRM)Key concepts in lean Manufacturing & SCM, Mass Customization, stages of manufacturing, Licensing- service operations management, Service Operations Optimizations, Types of Demand –Forecasting Approach Moving Averages, Customer Order Decoupling Points(CODP), Industries & their Classification, Supply Chain Strategy Collaborative planning Forecasting Replenishment Concepts(CPFR)

Module 6:

Best practice supply chain solutions. Internet-enabled supply chains: e-marketplaces, e-procurement, e-logistics, e-fulfilment, customer relationship management, web services, Rosetta net, ERP and supply chains, supply chain automation, and supply chain integration.

Text Books:

i) Supply Chain Management - Rahul v.Alterkar

ii) SCM - Sunil Chopra and Peter Meindl

iii) Richard J. Schonberger, World Class Manufacturing: The Lessons of Simplicity Applied, Collier Macmillian, London

iv) B S Sahay, K B C Saxena and Ashish Kumar, World-Class Manufacturing – A Strategic Perspective, Macmillan, Gunn, T.G., Manufacturing for Competitive Advantage: Becoming A world Class Manufacturer, Ballinger Publishing, 2007

ReferenceBooks:

i) Janat shah , Supply chain Management text & cases

ii) SarikaKulkarni, Supply chain Management

iii) Suzaki K, The New manufacturing Challenge: Techniques for Continuous Improvement, Free Press, New York.

iv) Shigeo Shingo, A Revolution in Manufacturing: The SMED System, Stamford, Conn. Productivity Press

Course Outcomes

CO-No.	Course Outcome	ModuleCovered
1	Provide a basic understanding about supply chain.	1
2	Understand the decision phases and apply competitive and supply chain strategies	3, 4, 5
3	Understand the role of aggregate planning, inventory, IT and coordination in a supply chain	2, 4,5
4	Understand drivers of supply chain performance	3,4, 6
5	Develop insights into Supply chain management concepts and its impact on Business	2,3,4,5,6

CO-PO Mapping (Rate: scale of 1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	1	3	1	1	2	1	2
CO-2	3	3	2	2	3	1	2	3
CO-3	2	2	3	3	2	2	3	3
CO-4	3	1	3	3	3	2	3	3
CO-5	3	2	3	3	2	3	2	3

ADVANCED OPTIMIZATION TECHNIQUES

Semester: 1st	Credit: 4					
CourseName:AdvancedOptimizationTechniques	**L**	**T**	**P**	3	1	0

CourseObjective:

1) DescribetheTraditionaloptimizationtechniquesand applyit inengineeringfield.
2) DistinguishbetweentheNonTraditionaloptimizationtechniquesandapplyitinengineeringfield.

Syllabus Content

Module 1:

IntroductionEngineering Applications of Optimization-Statement of an Optimization Problem-ClassificationofOptimization Problems-Optimization TechniquesPlanning of experiments – Steps – Need, Terminology: Factors, levels, variables, experimental error, replication, Randomization, Blocking, Confounding

Module 2:

Classical Optimization Techniques- Single-Variable Optimization, SingleFactorExperiments-ANOVA-Sumofsquares–Completelyrandomizeddesign,Randomized block design, Two and three Factor full factorial Designs,2^k designs with Two andThreefactors , effect of coding - Multivariable Optimization with No Constraints MultivariableOptimizationwithEqualityConstraints-MultivariableOptimizationwith InequalityConstraints-Transportation

Module 3:

Nonlinear Programming I- 1D Minimization Methods-Unimodal Function, Elimination Methods-Unrestricted Search, Exhaustive, Dichotomous Search-Interval Halving Method-Fibonacci Method-Golden Section Method, Interpolation Methods-Quadratic, Cubic Interpolation Method –Direct Root Methods –Newton Method-Quasi-Newton, Secant Method

Module 4:

Nonlinear Programming II- Unconstrained Optimization Techniques -Direct Search Methods – Indirect Search (Descent) Methods

Module 5:

Non-linear Programming III –Constrained Optimization Techniques- Direct Methods- Indirect Methods, Geometric Programming, Dynamic Programming, Integer Programming- Integer Linear Programming-Stochastic Programming.

Module 6:

Modern Methods of Optimization- Genetic Algorithms -Simulated Annealing -Particle SwarmOptimization -Ant Colony Optimization -Optimization of Fuzzy Systems - Neural-Network-BasedOptimization,Practical Aspects ofOptimization

TextBooks:

i) KalyanmoyDeb,"OptimizationforEngineeringdesign–algorithms&examples",PHI, New Delhi, 1995.

ii) Singiresu S.Rao, "Engineering optimization Theory and practices", John Wiley andSons, 1998.

iii) Garfinkel ,R.S.and Nemhauser,G.L.,"Integer programming",JohnWiley&Sons,1972

CourseOutcomes

CO-No.	CourseOutcome(4 to6)	ModuleCovered
1	Todescribeandexplaintradition optimization techniques	1
2	To ExplainthepracticalimplicationsofDesignof experiments	1
3	To describe non traditional optimization techniques	3,4,5
4	Beabletoknow about the modern methods of optimization	6
5	To be able to perform optimization analysis in real engineering field.	6

CO-POMapping(Rate: scaleof1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	1	2	2	1	1	2	3
CO-2	1	1	1	2	1	2	1	1
CO-3	2	1	2	2	3	1	2	2
CO-4	1	2	1	3	2	1	2	3
CO-5	3	2	2	2	3	2	3	3

QUALITY SYSTEMS ENGINEERING

Semester: 1st	Credit: 4					
Course Name: Quality Systems Engineering	**L**	**T**	**P**	3	1	0

Course Objectives:

1) Study of Quality concepts and Quality controls tools.
2) Study of TQM, QFD and FMEA for industrial applications.
3) Study of Quality Improvement Tools.
4) Understanding of implementation of TQM.
5) Implementation of TPM.
6) Study of New Quality concepts like SIX SIGMA, Agile and Lean Manufacturing.

Syllabus Content

Module 1:

INTRODUCTION- Quality – Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus.

Module 2:

Total Quality Management TQM:Introduction, Definitions and Principles of Operation, Tools and Techniques, such as, Quality Circles, 5 S Practice, Total Quality Control (TQC), Total Employee Involvement (TEI), Problem Solving Process, Quality Function Deployment (QFD), Failure Mode and Effect analysis (FMEA), Fault Tree Analysis (FTA), Quality Improvement Tools, TQM Implementation and Limitations.

Module 3:

Introduction to Total Productive Maintenance (TPM): Introduction, Content, Methods and Advantages

Module 4:

Contemporary Trends:Concurrent Engineering, Lean Manufacturing, Agile Manufacturing, World Class Manufacturing, Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation of all as applicable.

Text Books

i) Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers

ii)Statistical Quality Control by M. Mahajan, DhanpatRai& Co. (P) Ltd.

iii) Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India

iv) Total Quality Management by Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, Pearson Educaiton

v) Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.

Reference Books:

i) Total Quality Management: Poornima M. Charantimath, Pearson Education (Singapore) Pte. Ltd.

ii) Managing for Total Quality: N. Logothetis, Prentice Hall of India Pvt. Ltd.

iii) Competitive Manufacturing Management: John M. Nicholas, Mcgraw Hill

iv) Managing Quality: Barrie G. Dole, Blackwell publishing

v) TQM – an integrated approach – Samunel K Ho, Crest pubslishing House.

vi) Statistical Quality Control by Eugene L. Grant and Richard S. Leavenworth, McGraw-Hill Publishing Company Ltd.

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Discuss various dimensions of product and service quality	1
2	Apply the TQM principals for quality improvement	2
3	Distinguish between TQM tools and techniques used in Manufacturing and Service Sectors	2
4	Use QFD tool to design and develop a new product as per customer requirements	2
5	Explain the concept of Total productive maintenance	3
6	Summarize the basic concepts in Six sigma relevant to manufacturing and service	4

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO4	PO5	PO6	PSO1	PSO2
CO-1	1		3			2	1	1
CO-2	1	2	3	1		2	1	1
CO-3	1	2	2	1		2	1	1
CO-4	1	2	2			2	1	1
CO-5	1	2	2	1		3	1	1
CO-6	1	2	2	1		3	1	1

ELECTIVE III

PRODUCT DESIGN AND DEVELOPMENT

Semester : 2nd	Credit:4					
Course Name: Product Design and Development	**L**	**T**	**P**	3	1	0

Course objectives

1) To impart basic concepts of product design and development processes
2) To understand the integration of customer requirements in product design and develop ability to apply structural approach to concept generation, selection and testing.
3) To understand various aspects of design such as product architecture industrial design, design for manufacturing and economic analysis.

Syllabus Content

Module 1:

Introduction: Characteristics of successful product development, Challenges of product development, Structural approach to product development, Adapting generic product development process, Product development process flow.

Module 2:

Product planning and customer needs: Product planning process, identifying opportunities, evaluation and prioritizing projects, resources allocation and plan timing, Pre-project planning, Identifying customer needs, gathering of raw data from customers, Interpreting to customer needs and establishing of relative importance of needs.

Module 3:

Product specifications and concept generation: Processes for establishing target specifications, methods for setting the final specifications, concept generation, screening and evaluation methods.

Module 4:

Product architecture and industrial design: Methods of establishing product architecture, implications of product architecture, introduction to industrial design, study the impact of industrial design, Management of industrial design process and its quality assessment.

Module 5:

Design for manufacturing and product development economics: Definition, Estimation of Manufacturing cost, reducing the component costs and assembly costs, reducing system complexity - Prototype basics - Principles of prototyping, planning for prototypes, Economic Analysis of product

development.

Text Books:

i) Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, Anita Goyal, McGraw –Hill (2008)4th edition (SIE)

Reference Books:

i) Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1 / e 2004 , Pearson Education New Delhi

ii) www.mhhe.com/sie-ulrich4e

iii) Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", Wiley; Fourth edition (1 January 2015)

Course outcomes

CO No.	Course outcome	Module covered
1	Having the understanding of the processes involved in the product design and development.	1
2	Ability to evaluate customer needs and understand project planning	2
3	Ability to formulate product specifications and generate feasible concepts	3
4	Ability to apply industrial design principles in product development.	4
5	Ability to understand the product development for manufacturability and undertake economic analysis	5

CO-PO Mapping (Rate: scale of 1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	1	1	3	2	2	1	1
CO-2	2	3	1	1	1	2	2	2
CO-3	2	1	2	2	2	1	1	2
CO-4	2	1	2	2	1	1	1	1
CO-5	2	1	2	2	3	3	3	2

ADDITIVE MANUFACTURING

Semester: 2nd	Credit: 4					
Course Name: Additive Manufacturing	**L**	**T**	**P**	3	1	0

Course Objectives:

1. Understand the fundamentals for additive manufacturing and how it is different and discuss about various types of liquid based, solid based and powder-based AM technologies.
2. Understand the various types of Pre-processing, processing, post-processing errors in AM. Also, to know the various types of data formats and tools used in AM.
3. Understand the Rapid tooling concepts in Additive Manufacturing
4. Know the various applications of AM in design analysis, aerospace, automotive, biomedical and other fields.

Syllabus Content

Module 1:

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

Module 2:

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro fabrication.

Module 3:

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Module 4:

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Module 5:

Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies R19 M.Tech. Advanced Manufacturing Systems Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid, Tool Process, EOS Direct Tool Process and Direct Metal Tooling using

Module 6:

AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry

Text Books:

i) By C. K. Chua, K. F. Leong, C. S. Lim: Rapid Prototyping: Principles and Applications
ii) Additive manufacturing by C.P PAUL

Reference

i) Additive Manufacturing Technologies" by Ian Gibson and David Rosen
ii) Design for Additive manufacturing by Dr. Tom
iii) ADDITIVE MANUFACTURING by AmitBandyopadhyay ,Susmita Bose

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Basic of Additive manufacturing, Liquid based AM systems and it's Applications, Solid based AM systems and it's applications, Powder based AM systems and it's Applications	1,2,3,4
2	Various case studies on AM and Rapid tooling	5
3.	Study of Rapid Tooling	5
4	AM industrial applications	6

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO4	PO5	PO6	PSO1	PSO2
CO-1	1	2	2	3	1	3	3	2
CO-2	1	2	3	3	2	3	3	2
CO-3	1	1		3	2	3	3	2
CO-4	1	1	3	3	2	3	3	2

ELECTIVE III
MODELING AND SIMULATION OF MANUFACTURING PROCESSES

Semester: 2nd	Credit: 4					
Course Name: Modelling and simulation of manufacturing processes	**L**	**T**	**P**	3	1	0

Course Objectives:

7) To provide knowledge on simulation, simulation steps, parameter estimation and hypothesis.
8) To provide knowledge on building simulation model how to validation and verification is done.
9) To provide knowledge on Generation of random variants, variable and some Simulation languages.

Syllabus Content

Module 1

System – ways to analyze the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1& 2 errors – Framing – strong law of large numbers.

Module 2

Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

Module 3

Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – weibull – normal Bernoullie – Binomial – uniform – poison. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

Module 4

Output data analysis – Types of Simulation with respect to output data analysis – warm up period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – Comparisons.

Module 5

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – New boy paper problem.

Text Books:

i) Simulation Modelling and Analysis by Law, A.M. &Kelton, McGraw Hill, 2nd Edition, New York, 1991.

ii) Discrete Event System Simulation by Banks J. & Carson J.S., PH, Englewood Cliffs, NJ, 1984.

Reference Books:

i) Simulation of Manufacturing Systems by Carrie A., Wiley, NY, 1990.

ii) A Course in Simulation by Ross, S.M., McMillan, NY, 1990.

iii) Simulation Modelling and SIMNET by Taha H.A., PH, Englewood Cliffs, NJ, 1987.

iv) N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.

Course Outcomes

CO-No.	Course Outcome At the end of course, student should able to	Module Covered
1	Define the state of system W.R.T specified performance measures.	1
2	Identify Dynamic Discrete- event stochastic system.	2
3	Develop simulation model for the said system	2, 3
4	Analyze the model and present the results to specified confidence level.	4, 5
5	Interpret the model and apply the results to resolve critical issues in a real world environment.	4, 5

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	1	1	0	2	1	1	1	2
CO-2	1	0	0	1	1	2	1	1
CO-3	2	1	1	2	2	1	2	2
CO-4	1	2	1	3	2	1	2	3
CO-5	3	2	2	2	3	2	3	3

WELDINGTECHNOLOGY

Semester: 1st	Credit: 4					
Course Name: Welding Technology	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To impart a sound understanding of principles of different fusion welding processes.
2) To understand the effect of welding parameters on weld quality.
3) To study the importance of allied welding processes

Syllabus Content

Module1:

Welding Processes: heat flow in welding Basic classification of welding processes, weldability, weld thermalcycle, metallurgy of fusion welds, solidification mechanism and microstructural products in weldmetal,epitaxial,vcellularanddendriticsolidification,metallurgicalchangesinweldmetal,phasetransformationduringcoolingofweldmetalincarbonandlowalloysteel,predictionofmicrostructuresandpropertiesofweldmetal.Heataffectedzone,recrystallizationandgraingrowthofHAZ,gasmetalreaction,effectsofalloyingelementsonweldingofferrousmetals.

Module2:

The Welding ArcArc efficiency, temperature distribution in the arc; arc forces, arc blow, electricalcharacteristicsofanarc,mechanismofarcinitiationandmaintenance,roleofelectrodepolarityonarcbehaviour andarcstability,analysisofthearc.

Module3:

Arc welding consumables Electrode coatings, classification of coatings of electrodes for SMAW,SAWfluxes,roleoffluxingradientsandshieldinggases,classificationofsolidandfluxcodewires.

Module4:

Arc Welding power sources Arc welding power sources basic charterstics of power sources forvarious arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorised units, inverter systems. Arc length regulation in mechanized welding processes

Module5:

Metal Transfer in Arc Welding Mechanism and types of metal transfer, forces affecting metaltransfer,modesofmetaltransfer,metaltransferinvariousweldingprocesses,effectiveofpolarityonmetaltransferandmeltingrate.

Module6:

Solid State welding and other Allied processes Theory and mechanism of solid state welding. Techniques and scope of friction welding, diffusion welding, coldpressure welding and ultrasonic welding. High energy rate welding. Analysis of the Process. Welding Techniques using Radiation energy: Technique, scope and application of the electron beam and laser welding processes.

TextBooks:

i) Richard Little, Welding and Welding Technology, McGraw Hill, (2001), 1st edition.
ii) H Cary, Welding Technology, Prentice Hall, 1988, 2nd edition.
iii) S V Nadkarni, Modern Arc Welding Technology, Ador Welding Limited, 2010, New Delhi.

ReferenceBooks:

i) Welding handbook, American Welding Society, (1983), 7th edition, volume 1 & 2, USA
ii) http://eagar.mit.edu/EagarPapers/Eagar138.pdf
iii) http://www.techno4india.com/arc.pdf
iv) http://www.millerwelds.com/pdf/Paralleling.pdf

CourseOutcomes

CO-No.	Course Outcome	Module Covered
1	Todescribeandexplainfundamentalconceptsof welding and joining mechanism.	1
2	Toknow the details about welding arc.	2
3	Haveanunderstandingofarc welding consumables and power sources with basic calculations	3,4
4	Beabletoknow about the phenomenon of metal transfer in welding	5
5	Toknowabout other welding processes with different mode of joining.	6

CO-POMapping(Rate: scaleof1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	1	3	2	2	1	2	2
CO-2	1	2	1	2	3	2	3	2
CO-3	3	2	2	3	3	2	2	2
CO-4	2	3	1	2	2	3	3	2
CO-5	3	2	2	3	2	2	3	3

ELECTIVE IV
METAL CUTTING

Semester: 2nd	Credit: 4					
Course Name: Metal Cutting	**L**	**T**	**P**	3	1	0

CourseObjectives:

1) To have a clear understanding of tool geometry and cutting forces
2) To study tool materials, tool wear and tool life
3) To impart knowledge on the mechanics of metal cutting, machinability and dynamometry

Syllabus Content

Module1:

Introduction, system of Tool nomenclature, Tool Geometry, Mechanism of Chip, formation and forces in orthogonal cutting, Merchant's force diagram.

Module2:

Oblique Cutting: Normal chip reduction coefficient under oblique cutting, true shear angle, effective rake, influx region consideration for deformation, direction of maximum elongation, effect of cutting variables on chip reduction co-efficiient, forces system in oblique cutting, effect of wear land on force system, force system in milling, effect of helix angle.

Module3:

Fundamentals of Dynamometry, Theoretical determination of forces, angle relations, heat and temperature during metal cutting; distribution, measurement, analysis, theoretical estimation of work piece temperature, hot machining. Fundamental factors, which effect tool forces: Correlation of standard mechanised test. (Abuladze – relation), nature of contact and stagnant phenomenon, rates of strains, shear strain and normal strain distributions, cutting variables on cutting forces.

Module4:

Cutting Tools: Tools materials analysis of plastic failure (from stability criterion), Analysis failure by brittle fracture, wear of cutting tools, criterion, flank and crater wear analysis, optimum tool life, tool life equations, (Taylor's woxenetc)

Module5:

Tool life test, machining optimisation, predominant types of wear; abrasive, adhesive, diffusion wear models, wear measurements and techniques, theory of tool wear oxidative mathematical modelling for wear, test of machinability and influence of metallurgy on machinability.

Module6:

Economics of Metal machining. Abrasive Machining: Mechanics of grinding, cutting action of grit, maximum grit chip thickness, energy and grit force temperature during grinding, wheel wear, grinding, process simulation, testing of grinding wheels, mechanics of lapping and honing, free body abrasion.

TextBooks:

i) Metal Cutting Theory and Practice, A. Bhattacharya, New Central Book Agency (P) Ltd.

ii) Machining and Machine Tools, A. B. Chattopadhyay, Wiley-India Publication.
iii) Metal Cutting Principles, M. C. Shaw, Oxford University Press.

ReferenceBooks:

i) Boothroyd, Fundamentals of metal machining and machine tools, McGraw Kogakusha.
ii) T. H. C. Childs, K. Maekawa, T. Obikawa and Y. Yamane, Metal Machining, Theory and applications, Butter worth Heinemann
iii) Arshinov, Metal Cutting Theory and Design- MIR publishers.

CourseOutcomes

CO-No.	CourseOutcome	Module Covered
1	Provide fundamental knowledge in tool geometry, conversion from one system to another and mechanism of chip formation.	1
2	Develop the relations for chip reduction coefficient, shear angle, shear strain, forces, power, specific energy and temperatures associated with orthogonal cutting and oblique cutting.	2, 3
3	Develop the relations for forces in multipoint machining and oblique cutting.	2,6
4	Select suitable tools for different applications and identify methods to improve machinability	4,5
5	Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.	4,5,6

CO-PO Mapping (Rate: scaleof1 to3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	3	2	2	1	3	1
CO-2	2	2	3	2	2	1	2	1
CO-3	2	2	3	2	1	1	3	1
CO-4	2	2	3	2	1	2	2	3
CO-5	2	2	3	2	2	2	2	1

MACHINE TOOL DESIGN

Semester: 2nd	Credit: 4					
Course Name: Machine Tool Design	**L**	**T**	**P**	3	1	0

Course Objectives:

1) To develop fundamental knowledge of tool materials, cutting fluids and tool wear mechanisms.
2) To develop a solution-oriented approach to the knowledge of Machine Tool Design.
3) To address the underlying concepts, methods and applications of Machine Tool Design.

Syllabus Content

Module 1:

Introduction, Classification of machine tools, elements of machine tools, selection of speed and feed, gear box design various types of clutch systems, Sohopke and Report drives, doublebond gears analysis, Lohr criterion for optimising double bond gear,Steplessdrives,mechanicalstepless drive analysis, hydraulic step less drive & circuit analysis.

Module 2:

Strength and rigidity consideration, process capability and compliance, design of lathe bed, use of stiffness in bed, design of radial drill column and milling machine column. Analysis of spindle bearings, slides and guides, design of spindle/arbor, antifriction andjournal bearings, hydro-dynamic action in slides, analysis of hydrostatic bearings.

Module 3:

Vibrations of machine tools and dynamic rigidity: Effects of vibrations, source of vibrations,self-excited vibration, single degree of freedom chatter, velocity principle and related models,regenerative principles, chatter in lathe, drilling milling and grinding. Tlusty and palacemodel, Peters model.

Module 4:

Automation: Automation drives for machine tools, degree of automation, semi-automatics,analysis of collect action, design, of collet, bar feeding mechanism, tooling layout, singlespindle, multi-spindle automatic, transfer machine, indexing Geneva mechanism, analysis.

Module 5:

Control system of machine tools: Control: Mechanical, electrical, hydraulic, numerical,fluidic, basic principle of cam control, hydraulic controls, fluid controls, numerical controls,feedback systems, primary systems programming.

Text Books:

i) N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010.

ii) G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.
iii) D. K Pal, S. K. Basu, "Design of Machine Tools", 5th Edition. Oxford IBH, 2008.

Reference Books:

i) Machine tool design by Sen and Bhattacharya, CBS Publications.
ii) Technology of machine tools, S.F. Krar, A.R. Gill, Peter SMID, TMH (I).
iii) N. S. Acherkhan, "Machine Tool Design", Vol. I, II, III and IV, MIR publications, 1968.
iv) Design Principles of Metal-Cutting Machine Tools by F. Koenigsberger.

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Design and analyze kinematic motions in a machine tool.	1,2
2	Design and examine the systems that are used to achieve the desired speeds and feeds.	1,2
3	Based on design principles, evaluate methods for significant mechanical components of a machine tool.	2
4	Explain the reasons for chatter in machining and analyze vibrations so as to improve the machine tool performance.	2,3
5	To reduce friction and achieve high product accuracy, choose the right slide ways, spindles, and lead screws.	2,3,4
6	As part of quality assurance during machining, select relevant quality tests to be run on the machine tool.	2,5

CO-PO Mapping(Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	1	2	3	2	2	2
CO-2	1	3	1	3	2	2	1	2
CO-3	2	2	2	1	2	2	2	2
CO-4	2	3	1	3	1	2	1	2
CO-5	3	2	2	2	2	3	2	1
CO-6	2	2	2	1	2	2	1	2

ERGONOMICS & INDUSTRIAL MANUFACTURING

Semester: 2nd	Credit: 4					
Course Name: Ergonomics And Industrial Manufacturing	**L**	**T**	**P**	**3**	**1**	**0**

Course Objectives:

i) To learn about introducing Ergonomics and discipline approach
ii) To learn human physical dimension concern
iii) To learn posture, movement, behaviour and perception.
iv) To learn visual Issues and environmental factors
v) To learn ergonomic design process and performance support
vi) To learn design ergonomics in India

Syllabus Content

Module 1:

Introducing Ergonomics: Design today-Human aid to lifestyle.

Module 2:

Discipline approach: Ergonomics/ Human factors: Journey, Fitting task to man their contractual structure, Domain, Philosophy and Objective, Mutual task comfort: two way dialogue, communication model, Ergonomics/ human Factors fundamentals, Physiology (work physiology) and stress.

Module 3:

Human physical dimension concern: Human body- structure and function, anthropometrics, Anthropometry: body growth and somatotypes, Static and dynamic anthropometry,Stand Posture-erect, Anthropometry landmark: Sitting postures, Anthropometry: squatting and cross-legged postures, Anthropometric measuring techniques , Statistical treatment of data and percentile calculations.

Module 4:

Posture and movement: Human body- structure and function, Posture and job relation Posture and body supportive devices, Chair characteristics, Vertical work surface, Horizontal work surface, Movement,Work Counter.

Module 5:

Behavior and perception: Communication and cognitive issues, Psycho-social behavior aspects, behavior and stereotype, Information processing and perception Cognitive aspects and mental workload, Human error and risk perception.

Module 6:

Visual Issues: Visual performance,Visual displays

Module 7:

Environments Factors: Environmental factors influencing human performance

Module 8:

Ergonomic design process: Ergonomics design methodology, Ergonomics criteria/check while designing, Design process involving ergonomics check, some checklists for task easiness.

Module 9:

Performance support and design intervention: Occupational safety and stress at workplace in view to reduce the potential fatigue, errors, discomforts and unsafe acts, Workstation design, Furniture support, Vertical arm reach and design application possibility,Humanizing design: Design and human compatibility, comfort and adaptability aspects.

Module 10:

Design Ergonomics in India: Design Ergonomics in India: scope for exploration.

Text Books:

i) Bridger, RS: Introduction to Ergonomics, 2nd Edition, Taylor &Francis, 2003.

ii) Dul, J. and Weerdmeester, B. Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.

iii) Green, W.S. and Jordan, P .W, Human Factors in Product Design, Taylor &rancis, 1999.

References Books

i) D. Chakrabarti, Indian Anthropometric Dimensions for ergonomic design practice, National Institute of Design, Ahmedabad, 1997

ii) G. Salvendy (edit), Handbook of Human Factors and ergonomics, John Wiley & Sons, Inc., 1998

iii) Singh, S (Edt), Ergonomics Interventions for Health and Productivity, Himanshu Publications, Udaipur, New Delhi, 2007

Course Outcomes:

CO-No.	Course Outcome	Module Covered
1	Introducing Ergonomics and discipline approach	1, 2
2	Human physical dimension concern	3
3	Posture, movement, behaviour and perception	4, 5
4	Visual Issues and environmental factors	6, 7
5	Ergonomic design process and performance support	8, 9
6	Design Ergonomics in India: scope for exploration	10

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	3	2	3	2	2	2	3	2
CO-2	2	3	3	2	3	3	3	3
CO-3	3	3	2	2	3	2	2	3
CO-4	3	2	3	3	2	3	3	3
CO-5	2	3	2	2	3	3	2	3
CO-6	3	3	3	2	2	3	3	3

ROBOTICS

Semester: 2nd Sem	Credit: 4					
Course Name: Robotics	**L**	**T**	**P**	3	1	0

Course Objectives

1) Application of Robot and automation process in fabrication and production entangling design/selection process.

Syllabus content

Module 1:

Introduction: Automation & robotics, Robotic System & Anatomy Classification, Future Prospects

Module 2:

RoboticApplication in Manufacturing:Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspectors

Module 3:

Social Issues and Economics of robotics Drives: Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators, Power Transmission Systems.

Module 4:

Robot &its Peripherals: End Effecters - types, Mechanical & other grippers, Tool as end effecter

Module 5:

Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems

Module 6:

Robotic Cell Design & Control, Robot Kinematics: Coordinate Frames, Rotations, Homogeneous Coordinates, Arm Equation of Planer Robot, Four axis SCARA Robot, TCV, Inverse Kinematics of Planer Robot, Four Axis SCARA Robot.

Module 7:

Trajectory Planning & Robot Dynamics: Manipulator Path Control- Linear, Quadratic and Cubic Interpolation, Work Space Analysis, Robot Dynamics –Langrangian Dynamics of one and two link robot arm

Module 8:

Programming for Robots: Methods, Robot programmed as a path in space, Motion interpolation, level & task level languages, Robot languages; Programming in suitable languages Characteristics of robot

Text Book

i) Mark Spong, “Robot Dynamics and Control”, Wiley India

ii) John Craig, “Robotics”

iii) Paul R.P., “Robot Manipulators: Mathematics, Programming and Control”
iv) Grover and Simmers,“Industrial Robotics”
v) Ernest Deoblin,“Measurement systems”
vi) Ramamurthy, “Computer Aided Design in Mechanical Engineering”

References Books:

i) YoremKoren, “Robotics for Engineers”
ii) J. F. Engelberger, “Robotics in Practice”
iii) Ulrich Rembolds, ChristialBlume, “Computer Integrated Manufacturing Technology and Systems”
iv) Beckwith and Lewisbuck, “Mechanical Measurements”
v) K. Ogata,“Modern Control Engineering”,PHI
vi) Benjamin Kuo, “Automatic Control Systems”, Wiley India
vii) Richard D. KIafter et al, “Robotic Engineering -an Integrated Approach”, PHI
viii) Spyros G. Tzafestas, “Intelligent Robotic Systems”

Course Outcomes

CO-No.	Course Outcome	Module Covered
1	Learning about robots types and application in industry.	1, 2
2	To study the economics and social issues in robot applications.	3
3	To study the end effectors and sensors of robots, robot visions.	4, 5, 8
4	To study the robot manipulator’s kinematics and dynamics.	VI & VII
5	To study the manufacturing cell, a step towards production.	6
6	Designing of pathways and programing of robots.	7, 9

CO-PO Mapping (Rate: scale of 1 to 3)

Course Outcome	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2
CO-1	2	2	2	2	3	3	3	3
CO-2	2	2	2	3	3	2	3	3
CO-3	3	2	3	2	3	3	3	3
CO-4	2	2	2	3	3	2	3	3
CO-5	2	2	2	2	3	3	3	3
CO-6	2	2	3	3	3	2	3	3