2101MF101	PROBABILITY AND STATISTICS IN MANUFACTURING	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To introduce the concepts of sampling distributions and the teststatistics.
- To provide an understanding of the statistical methods and concepts by which real life problems are analyzed.
- To analyze various data using statistical techniques.
- To train the students in design experiments and use these concepts for research.

MODULE 1	PROBABILITY THEORY	12 Hours

Random variables –probability density and distribution functions-moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications inmanufacturing.

MODULE 2	SAMPLING THEORY	12 Hours

Sampling distributions – Standard error – t, F, Chi square distributions – applications in manufacturing.

MODULE 3	ESTIMATION THEORY	12 Hours

Interval estimation for population mean, standard deviation, difference in means, preparation ratio of standard deviations and variances- applications in manufacturing.

MODULE 4	TESTING OF HYPOTHESIS AND ANOVA	12 Hours

Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations – Tests based on chi square – and Redistribution test -Design of experiments - applications in manufacturing.

MODULE 5	ANOVA	12 Hours

Design of experiments – One, Two factor Models- applications in manufacturing

	Total:	60 Hours

COURSE OUTCOME

CO1: Formulate and find optimal solution in the real life optimizing/allocation/assignment problems involving conditions and resource constraints.
CO2 : Simulate appropriate application/distribution problems.
CO3 : Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
CO4 : Apply the concept of various test statistics used in hypothesis testing for mean and variances of large and small samples.
CO5 : Get exposure to the principal component analysis of random vectors and matrices.

REFERENCES

1. Jay L.Devore, "Probability an Statistics for Engineering and the Sciences", Cengage Learning, 9th Edition, Boston, 2016.
2. Johnson, R.A, Irwin Miller and John Freund., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, 9th Edition, New York,2016.
3. Johnson, R.A., and Wichern, D.W., "Applied Multivariate Statistical Analysis", Pearson Education, Sixth Edition, New Delhi, 2013.
4. Ross. S.M., "Probability Models for Computer Science", Academic Press, SanDiego, 2002.
5. Taha H.A.,, "Operations Research: An Introduction", Prentice Hall of IndiaPvt.

2102MF102	MODERN MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

- To create awareness on Abrasive aided machining
- To understand electrical and electrochemical machining processes.
- To analyses the principles of high energy aided machining.
- To study the surface and bulk machining processes of silicon wafer.
- To introduce students to the major manufacture steps in electronic circuit boards.

MODULE 1	ABRASIVE AIDED MACHINING PROCESSES	9 Hours

Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining- Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining- Magneto rheological Abrasive flow machining- construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

MODULE 2	ELECTRICAL AND CHEMICAL AIDED MACHINING PROCESSES	9 Hours

Wire cut EDM - Electric discharge machining – Electrochemical machining – chemical machining– Mask ants - Electrochemical grinding - construction – principle – types – control - circuits – tool design – merits, demerits and applications. Hybrid Machining.

MODULE 3	HIGH ENERGY AIDED MACHINING PROCESSES	9 Hours

Laser beam machining – Electron beam machining – Plasma arc machining – ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

MODULE 4	FABRICATION OF MICRO DEVICES	9 Hours

Semiconductors – Si wafer - planarization – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process

MODULE 5	MICROFABRICATION TECHNOLOGY	9 Hours

Molding – PCB board hybrid and MCM technology – programmable devices and ASIC – electronic material and processing– stereo lithography – Solid free form fabrication -SAW devices, Surface Mount Technology

	Total:	45 Hours

COURSE OUTCOME

CO1 : Understand and grasp the significance of modern machining process and its applications.
CO2 : Identify the selection of machining process and its parameters.
CO3 : Express and appreciate the cutting edge technologies and apply the same for research purposes.
CO4 : Measure the stages involved in fabrication of micro devices.
CO5 : Create new devices involved in micro fabrication and recent technology.

REFERENCES

1. Brahem T. Smith, Advanced Machining I.F.S. UK. 2016.
2. Jaeger R.C., Introduction to Microelectronic Fabrication Addison Wesley, 2ndEdition, 1998.
3. Jain V K, Micromanufacturing Processes, CRC Press, 2012.
4. Julian W. Gardner, Vijay K Varadan and Osama O Awadelkarim, Microsensors MEMS and Smart devices, John Wiley, 2013.
5. Pandey P.C. and Shan HS Modern Machining Processes, Standard Publishing Co., 1stEdition,1980.
6. Serope Kalpakjian and Steven R. Schmid- Manufacturing Process for Engineering Material – Pearson Education, 6thEdition, 2018

PROGRAM ELECTIVE–I

2103MF001	THEORY OF METAL FORMING	L	T	P	C
		3	0	0	3

MODULE 1	THEORY OF PLASTICITY	9 Hours

Theory of plastic deformation – Yield criteria – Tresca and Von-Mises – Distortion energy – Stress- strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.

MODULE 2	THEORY AND PRACTICE OF BULK FORMING PROCESSES	9 HOURS

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.

MODULE 3	SHEET METAL FORMING	9 Hours

Formability studies – Conventional processes – High energy rate forming (**HERF**) techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application – Incremental forming.

MODULE 4	POWDER METALLAURGY AND SPECIAL FORMING PROCESSES	9 Hours

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isotactic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

MODULE 5	SURFACE TREATMENT AND METAL FORMING APPLICATIONS	9 Hours

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging. Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

	TOTAL:	45 Hours

REFERENCES

1. Altan T, Metal forming – Fundamentals and applications – American Society of Metals, Metalspark,1983.
2. Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes andEquipment, CRC publication press,1st Edition,2017.
3. Marciniak Z, Duncan J.L., Hu S.J., Mechanics of Sheet Metal Forming, Butterworth-Heinemann,2nd Edition, 2002.
4. Nagpal G.R, Metal Forming Processes, Khanna publishers, 2005.
5. Shiro Kobayashi, Soo-Ik-Oh-Altan T, Metal forming and Finite Element Method, Oxford UniversityPress,1989.
6. Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,1st Edition,2008.

PROGRAM ELECTIVE–II

2103MF007	ADVANCED WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE 1	ARC AND GAS WELDING PROCESSES	9 Hours

undamental Principles – Air Acetylene Welding, Oxyacetylene Welding, Carbon Arc Welding, Shielded Metal Arc Welding, ubmerged Arc Welding, TIG and MIG Welding, Plasma Arc Welding and Electro slag Welding Processes– Advantages, imitations and Applications - Spot Welding, Seam Welding, Projection Welding, Resistance Butt Welding, Flash Butt Welding, Percussion Welding and High Frequency Resistance Welding Processes – Advantages, Limitations and Applications – obotic Welding

MODULE 2	SOLID STATE AND SPECIAL WELDING PROCESSES	9 Hours

Cold Welding, Diffusion Bonding, Explosive Welding, Ultrasonic Welding, Friction Welding, Friction Stir Welding- Forge Welding, Roll Welding and Hot Pressure Welding Processes – Advantages, Limitations and Applications - Thermite Welding, Atomic Hydrogen Welding, Electron Beam Welding, Laser Beam Welding, Friction Stir Welding, Under Water Welding, Welding Automation In Aerospace, Nuclear and Surface Transport Vehicles.

MODULE 3	WELDING METALLURGY	9 Hours

eometry, plate thickness, preheat, significance of thermal severity number, Epitaxial growth - weld metal solidification - olumnar structures and growth morphology effect of welding parameters - absorption of gases - gas/metal and slag/metal eactions, Phase transformations- weld CCT diagrams-carbon equivalent-preheating and post heating weld ability of low alloy teels, welding of stainless steels use of Schaffler and Delong diagrams, welding of cast irons - Welding of Cu, Al, Ti and Ni lloys – processes, difficulties, microstructures, defects and remedial measures, Origin - types -process induced efects, - significance - remedial measures, Hot cracking - cold cracking -lamellar tearing - reheat cracking – weld ability tests effect of metallurgical parameters,.

MODULE 4	DESIGN OF WELDMENTS	9 Hours

ype of joints, joint efficiency, factor of safety, symbols, selection of edge preparation, design considerations, types of oading, Permissible stress, allowable defects, computation of stresses in welds, weld size calculation, code requirement or statically loaded structures - Design for fluctuating and impact loading - dynamic behavior of joints stress, concentrations - fatigue analysis fatigue improvement techniques - permissible stress- life prediction, Concept of tress intensity factors - LEFM and EPFM concepts - brittle fracture- transition, temperature approach - fracture toughness esting, application of fracture mechanics to fatigue Welding residual stresses - causes, occurrence, effects and measurements - thermal and mechanical relieving; types of distortion - factors affecting distortion - distortion ontrol methods - prediction - correction, jigs, fixtures and positioners

MODULE 5	WELDING DEFECTS AND INSPECTION	9 Hours

lassification of weld defects- General sources of weld defects- Arc welding defects- Weld defects in other than Arc elding processes. Resistance welding defects- Defects in Friction welding- Defects in friction stir welding - Defects in elds of other welding processes-Visual Inspection-Liquid Penetrant Inspection- Magnetic particle inspection- Ultra onic testing(UT) Radiography testing (RT) - Eddy current testing –Thermography- Optical and Acoustical olography.

	TOTAL:	45 Hours

REFERENCES

1. Baldev Raj, Practical Non – Destructive Testing, Narosa PublishingHouse,2009.
2. Lancaster J.F, Metallurgy of Welding, Abington Publishing,6th Edition, 1999.
3. Linnert G. E.,"Welding Metallurgy', Volume I and II, AWS,4thEdition, 1994
4. Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007
5. Parmer R.S., "'Welding Engineering and Technology", Khanna Publishers,1stEdition New Delhi,2008.
6. Welding Handbook, Volume 2, 7thEdition, American Welding Society

2101RMX01	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

MODULE 1	RESEARCH PROBLEM FORMULATION	9 Hours

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

MODULE 2	LITERATURE REVIEW	9 Hours

Effective literature studies approaches, analysis, plagiarism, and research ethics.

MODULE 3	TECHNICAL WRITING /PRESENTATION	9 Hours

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

MODULE 4	INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)	9 Hours

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

MODULE 5	INTELLECTUAL PROPERTY RIGHTS (IPR)	9 Hours

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

	Total :	45 Hours

COURSE OUTCOME

CO1 : To formulate research problem
CO2 : To carry out research analysis
CO3 : To follow research ethics
CO4: To understand that today's world is controlled by computer, information technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5 : To understand about IPR and filing patents in R & D.

REFERENCES

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

AUDIT COURSES

2101AU001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

1. Teach how to improve writing skills and level of readability
2. Tell about what to write in each section
3. Summarize the skills needed when writing a Title
4. Infer the skills needed when writing the Conclusion
5. Ensure the quality of paper at very first-time submission

MODULE I	**INTRODUCTION TO RESEARCH PAPER WRITING**	**6 Hours**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

MODULE II	**PRESENTATION SKILLS**	**6 Hours**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

MODULE III	**TITLE WRITING SKILLS**	**6 Hours**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

MODULE IV	**RESULT WRITING SKILLS**	**6 Hours**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

MODULE V	**VERIFICATION SKILLS**	**6 Hours**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

Total:	**30 Hours**

FURTHER READING: -

COURSE OUTCOMES:

CO1	Understand that how to improve your writing skills and level of readability
CO2	Learn about what to write in each section
CO3	Understand the skills needed when writing a Title
CO4	Understand the skills needed when writing the Conclusion
CO5	Ensure the good quality of paper at very first-time submission

References:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies ""New Royal book Company.
2. Sahni, Pardeep Et. Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

2102MF103	COMPUTER AIDED MANUFACTURING LAB	L	T	P	C
		0	0	4	2

AIM:

- To impart the knowledge on training the students in the area of CAM
- To teach the students about programming of CNC machines
- To train them to use the various sensors

EXPERIMENTS:

1. Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving& canned cycle
2. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle.
3. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.

Total : 60 Hours

OUTCOMES:

Students will be able to
CO1 : Understand and grasp the significance of modern machining process and its applications through hands-on experience.
CO2 : Identify the selection of machining processes and its process parameters.
CO3 : Express and perform project related works.

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Approved in VI Academic Council Meeting held on 06.03.2021

2102MF104	METAL FORMING AND METAL TESTING LABORATORY	L	T	P	C
		0	0	4	2

AIM:

- To impart practical knowledge on bulk metal forming and sheet metal forming processes

OBJECTIVE

- To train the students to have an hands on having the basic concepts of metal forming processes and to determine some metal forming parameters for a given shape.

EXPERIMENTS

1. Determination of strain hardening exponent
2. Determination of strain rate sensitivity index
3. Determination of efficiency in water hammer forming
4. Determination of interface friction factor
5. Study on rolling process
6. Determination of torque and force measurement in rolling mill.
7. Analysis of cutting forces on a lathe.
8. Measurement of torque on milling machine.

TOTAL: 60 Hours

OUTCOMES:

Students will be able to
CO1 : Understand and grasp the significance of modern machining process and its applications through hands-on experience.
CO2 : Identify the selection of machining processes and its process parameters.
CO3 : Express and perform project related works.

PCC		INDUSTRIAL AUTOMATION AND MECHATRONICS	L	T	P	C
2102MF201			3	0	0	3

Course Objectives:

1. This syllabus is formed to create knowledge in Industrial Automation and Mechatronics systems and impart the source of concepts and techniques, which have recently been applied in practical situation
2. It gives the frame work of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

MODULE I	**INDUSTRIAL AUTOMATION**	**8 Hours**

Role of automation in industries, Benefits of automation –Introduction to fluid power, Advantages of fluid power, Application of fluid power system -Types of fluid power systems -Introduction to automation tools: Low cost automation, PLC, DCS, SCADA -Automation strategy evolution.

MODULE II	**INTRODUCTION TO MECHATRONICS**	**8 Hours**

Introduction to Mechatronics-systems – Mechatronics approach to modern engineering and design – Need of Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics – Mechatronics elements

MODULE III	**SENSORS AND TRANSDUCERS**	**12 Hours**

Introduction – Performance Terminology – Potentiometers – Strain gauges – LVDT – Eddy current sensor – Hall effect sensor – Capacitance sensors – Digital transducers – Temperature sensors – Optical sensors – Piezo electric sensor-ultrasonic sensors – Proximity sensors – Signal processing techniques.

MODULE IV	**ACTUATORS**	**8 Hours**

Switching Devices, Classification of actuators – Electrical actuators – Solid state relays, solenoids, D.C. motors, Servo motors, Stepper motors – Interfacing with microcontroller through H-bridge Circuits – Piezo electric actuators.

MODULE V	**MECHATRONIC SYSTEMS**	**9 Hours**

Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies – Engine management system, Automatic camera, Automatic washing machine, Pick and place robots.

Total:	**45 Hours**

Course Outcomes:

CO1	: Understand the concepts of industrial automation
CO2	: Discuss the components of Mechatronic systems.
CO3	: Select the suitable sensors and transducers in an automation application
CO4	: Select the most appropriate actuators for an engineering application
CO5	: Explain mechatronic systems with case studies.

References:

1. R.K.Rajput. A Text Book of Mechatronics, Chand &Co,2
2. W.Bolton, Mechatronics, Pearson Education Limited,2004
3. M.A. Mazidi & J.G. Mazidi, 8051 Microcontroller and embedded systems,2002
4. Devadasshetty, Richard A. Kolk, —Mechatronics System Design, PWS Publishing Company, 2001.

PCC		ROBOT DESIGN AND PROGRAMMING	L	T	P	C
2102MF202			3	0	0	3

Course Objectives:

- To gain knowledge on growth of robots since origin based on the application.
- To study the kinematics of robot.
- To study the dynamics of robot.
- To expose the students in the various programming techniques in robot and illuminate the curiosity over recent AI techniques.
- To familiarize the sensors and actuators involved in the robot based the application.

MODULE I	**INTRODUCTION**	**9 Hours**

Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

MODULE II	**ROBOT KINEMATICS**	**9 Hours**

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Changes between frames:

MODULE III	**ROBOT DYNAMICS AND TRAJECTORY PLANNING**	**9 Hours**

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

MODULE IV	**ROBOT PROGRAMMING AND AI TECHNIQUES**	**9 Hours**

Types of Programming – Teach Pendant programming – Basic concepts in AI techniques – Concept of knowledge representations – Expert system and its components.

MODULE V	**ROBOT SENSORS AND ACTUATORS**	**9 Hours**

Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non contact sensors, infrared sensors, RCC, vision sensors.

Total:	**45 Hours**

Course Outcomes:

Students will able to

- CO1 : Apply their knowledge on calculation of end effector coordinate position and angle based onthe application.
- CO2 : Calculate force involved in the robot while under operation (i.e. gripping force).
- CO3 : Compute the trajectory of robot based on both joint space and Cartesian space.
- CO4 : Understand the traditional programming in robot and Modern AI Techniques.
- CO5 : Identify appropriate sensors and actuators based on the application.

References:

1. Fu K S, Gonzalez, Lee C S G, Robotics: Control, Sensing, Vision and Intelligence, McGraw- Hill Book Company, 1987.
2. Gordon Mair, "Industrial Robotics", Prentice Hall U.K, 1998.
3. Groover.M.P. Industrial Robotics, McGraw – Hill International edition, 2012.
4. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 3rd edition, 2004.
5. Saeed.B.Niku, "Introduction to Robotics, Analysis, system, Applications", Pearson educations, 2010.
6. Wesley E Snyder R, "Industrial Robots, Computer Interfacing and Control", Prentice Hall International Edition, 2013.

PCC		MATERIALS TECHNOLOGY	L	T	P	C
2102MF203			3	0	0	3

Course Objectives:

- To understand the elastic and plastic behaviour of materials.
- To impart knowledge on fracture analysis.
- To familiarize on modern metallic materials.
- To review on polymeric and ceramics materials and their applications.
- To enable student to select material for specific applications.

MODULE I **ELASTIC AND PLASTIC BEHAVIOR** **9 Hours**

Elasticity in metals and polymers Anelastic and visco-elastic behaviour – Mechanism of plastic deformation shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre, dispersion and texture strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Deformation of polymeric, ceramic and non-crystalline materials.

MODULE II **FRACTURE BEHAVIOUR** **9 Hours**

Griffith's theory, stress intensity factor, J-Integral and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test,crack initiation and propagation mechanisms and Paris law. Effect of surface and metallurgical parameters on fatigue – Fracture in ceramics and polymers – Failure analysis, sources of failure, procedure of failure analysis.

MODULE III **MODERN METALLIC MATERIALS** **9 Hours**

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel, Super alloys –Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass nano crystalline materials and composite materials.

MODULE IV **NON METALLIC MATERIALS** **9 Hours**

Polymeric materials – Formation of polymer structure – Production techniques of fibres, foams, adhesives and coating – structure, properties and applications of Commodity and engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, applications as abrasives and cutting tool- Properties and applications of CNT – Graphene based Material

MODULE V **SELECTION OF MATERIALS** **9 Hours**

Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for Atmospheric, water, Soil and chemical, corrosion Selection for adhesive and abrasive wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery, chemical and nuclear applications.

Total: **45 Hours**

Course Outcomes:

Students will able to

CO1 : Get knowledge of mechanism of failure of materials and methods.

CO2 : Fully appreciate modification of material property to suit the specific requirements.

CO3 : Express and appreciate the existing materials and development of upcoming new materials.

CO4 : Have the knowledge to select the various non-metallic materials to suit required applications

CO5 : Identify and select suitable material for relevant application.

References:

1. Ashby M.F., Material Selection in Mechanical Design, 5thEdition, Butter Worth 2017.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, 10thEdition, ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Furness, J.A.G., Selection and use of engineering materials, 3rd edition, Butterworth-Heiremann, 2001.
4. Thomas H. Courtney, Mechanical Behaviour of Materials, 2ndedition, McGraw Hill, 2000.
5. Marc Andre, Meyers and Krishan Kumar Chawla, Mechanical Behaviour of Materials, 2ndEdition, Cambridge University Press, 2009.
6. George E.Dieter, Mechanical Metallurgy, 3rd Edition,McGraw Hill, 2014.

PEC			L	T	P	C
2103MF012		PRODUCTION AND OPERATIONS MANAGEMENT	3	0	0	3

Course Objectives:

- To familiarize with various forecasting models.
- To impress upon the importance of sequencing problem in industries.
- To design and develop inventory control models for a given industry.
- To familiarize with project management techniques such as CPM and PERT.
- To train on plant engineering techniques such as plant location, plant layout, materials handling and work study.

MODULE I	FORECASTING	9 Hours

Forecasts-Types-Purpose- opinion and judgmental method-Time series methods – moving average - weighted moving average – method of least squares – Exponential smoothing method- Regression and correlation methods – simple and multiple regression – Linear and Nonlinear regression.

MODULE II	SCHEDULING AND SEQUENCING	9 Hours

Scheduling – Single Criterion rules –Sequencing –n job 2 machine problem – Johnson's algorithm –3 machine problem – M machine problem – Graphical method for 2 jobs M machine problems – Heuristic methods.

MODULE III	INVENTORY	9 Hours

Inventory – purpose of inventory – Basic EOQ Model –Quantity discount model – Reorder level – Fixed order quantity inventory system – Periodic review system – ABC analysis – Materials requirement planning – EOQ models under constraints – Purchasing management – Stores management – Just In Time inventory system – Vendor evaluation - Inventory pricing – Supply chain Management – Aggregate planning.

MODULE IV	PROJECT MANAGEMENT	9 Hours

Project network analysis – Activities – Events- critical path method – Method based on time estimates– Programme Evaluation Review Technique –Optimistic, pessimistic time, most likely time - Probability of completion of projects – Time crashing of Projects –Optimum duration and cost.

MODULE V	PLANT ENGINEERING AND WORK STUDY	9 Hours

Plant location – Factors affecting plant location – Break even analysis- Factors weighted ratingmethod – Plant layout-Types- Selection – Plant layout Techniques – Travel chart method – Line balancing method– Work study – method study – Principles of Motion economy – steps in methods study - Charts – Micromotion study-memo motion study – multiple activity charts- therbligs – work measurement – stop watch time study – Production studies – PMTS – Work sampling – Materials handling – Principles – Selection.

	Total:	45 Hours

Course Outcomes:

Students will be able to

CO1 : Select an appropriate forecasting method for a given industry

CO2 : Obtain optimal solutions for sequencing problem in industry.

CO3 : Design a suitable inventory system for any particular industry.

CO4 : Use the project management techniques to minimize the project time.

CO5 : Design plant layout and materials handling systems and can make use of the concepts of workstudy for work design.

References:

1. Chary S.N Production and Operations Management, Tata McGraw Hill, 3rd Edition 2012.
2. Kanishka Bedi, Production and Operations Management, Oxford University Press,3rdEdition 2016.
3. Norma Gaither and Gregory Frazier, Operations Management, Cengage Learning, 9thEdition,2016.
4. Panneerselvam R, Production and Operations Management, Prentice Hall of India, 2ndEdition, 2008.
5. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, McGraw Hill,14th edition, 2017.
6. William J Stevenson, Operations Management, McGraw Hill, 11th edition, 2012.

PEC		PROCESSING OF POLYMERS AND COMPOSITES	L	T	P	C
2103MF013			3	0	0	3

Course Objectives:

- To introduce the various processing methods of polymers.
- To enlighten the students about the different types of fibres and matrix materials.
- To analyse the different polymer matrix composites processing methods and their applications.
- To expose the students to the various metal matrix composite processing methods.
- To analyse the various processing techniques of various ceramic matrix composites.

MODULE I	PROCESSING OF POLYMERS	9 Hours

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

MODULE II	FIBRES AND MATRIX MATERIALS	9 Hours

Fibres – Fabrication, Structure, properties and applications – Glass fibre, Boron fibre, carbon fibre, organic fibre, ceramic and metallic fibres - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

MODULE III	PROCESSING OF POLYMER MATRIX COMPOSITES	9 Hours

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites– film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs-structure, properties and application of PMCs –recycling of PMCs.

MODULE IV	PROCESSING OF METAL MATRIX COMPOSITES	9 Hours

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

MODULE V	PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES	9 Hours

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – insitu chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel-interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites-applications.

	Total:	45 Hours

Course Outcomes:

Students will be able to

- CO1 : Get knowledge on various processing methods of polymers.
- CO2 : Get knowledge about various types of fibres and matrix materials.
- CO3 : Understand the various polymer matrix composites processing methods.
- CO4 : Analyse the various processing methods of metal matrix composites.
- CO5 : Analyse the various processing techniques of ceramic matrix composites.

References:

1. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
2. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009.
3. Krishan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012.
4. Mallick P.K. and Newman S, Composite Materials Technology, Hanser Publishers, 2003.
5. Mallick P.K., Fibre Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010.
6. Seamour E.B, Modern Plastics Technology, Prentice Hall, 2002

2101AU002 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

MODULE I INTRODUCTION **6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

MODULE II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

MODULE III DISASTER PRONE AREAS IN INDIA **6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

MODULE IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and CommMODULEy Preparedness.

MODULE V RISK ASSESSMENT **6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

PCC		INDUSTRIAL AUTOMATION AND MECHATRONICS LABORATORY	L	T	P	C
2102MF204			0	0	4	2

Course Objectives:	
	To train the students to have a hands on training of the basic concepts of various industrial automation and Mechatronics systems
Experiments:	
1. Simulation of single and double acting cylinder circuits	
2. Simulation of Hydraulic circuits	
3. Simulation of electro pneumatic circuits	
4. Simulation of electro hydraulic circuits	
5. Simulation of PLC circuits	
6. Software simulation of fluid power circuits using a software package.	
7. Simulation of various Mechatronics systems using hardware components	
	Total: 60 Hours
Course Outcomes:	
	Students will be able to
	CO1 : Create the pneumatic and hydraulic circuits using autoSIM software.
	CO2 : Prepare PLC ladder programming for industrial applications.
	CO3 : Design a mechatronics system according to an industrial applications.

PCC		MODELLING AND SIMULATION LABORATORY	L	T	P	C
2102MF205			0	0	4	2

Course Objectives:

- To study the fundamentals of finite element analysis from classical method to nodal approximation method in various fields of manufacturing applications.
- To make the students to design an element by Finite element analysis.
- To develop the knowledge related to modelling and simulation in field of manufacturing.

LIST OF EXERCISES

1. One Dimensional FEA Problem like beam, Truss etc.
2. Two Dimensional FEA Problems like plane stress, plane strain, axisymmetric and vibration.
3. Three Dimensional FEA Problems like shell and contact.
4. FEA Application in metal forming like superplastic forming, deep drawing etc
5. FEA Application in Metal cutting
6. FEA Application in Casting process
7. 3D Modelling and Assemble of Engine
8. Modelling of Crack Shaft
9. Modelling of Connecting Rod
10. Modelling of Cotter Joint
11. Modelling of Plummer Block and Coupling

(Any 10 for Conduct of end semester examination)

Total: 60 Hours

Course Outcomes:

Students will be able to

CO1 : Apply the principles of Finite Element Analysis to solve problems in the field of production engineering.

CO2 : design and analyse various problems in field of manufacturing

CO3 : identify the problems and simulate using Finite element analysis

CO4 : Relate to Finite element analysis in various manufacturing applications.

CO5 : Develop skills in field of design and simulation using FEA.

PCC		MINI PROJECT WITH SEMINAR	L	T	P	C
21MF206			0	0	2	1

Objectives:	
	• To prepare students to identify a problem for study.
	• To do literature review of a problem.
	• To enable to comprehend information in form of presentation both written and oral, to develop technical communication skills.
	• To carry out modelling/ conduct experiments beyond regular laboratory exercises in developing solution to the identified problem.
	• To cultivate spirit of team work in working as a group.
	A student has to choose a problem and carry out scientific systematic investigation experimentally/ theoretically in suggesting a viable solution. At the end of the semester, each group of students have to submit a report for evaluation.
	TOTAL: 30 PERIODS

OUTCOMES
Students at the end of course will be
• To critically observe the world around and identify a problem that can be solved.
• To develop skills of read and comprehensively analysing the facts.
• To exhibit skill of presentation both orally and in written form.
• To get hands on experience to doing experimental/ theoretical analysis in synthesis ofsolution to the problem
• Able to appreciate the importance of team work

1703MF011	RAPID PROTOTYPING	L	T	P	C
		3	0	0	3

PREREQUISITE :

1. Manufacturing Technology – I
2. Manufacturing Technology – II

COURSE OBJECTIVES:

1. To make the students to understand the importance of time compression technologies
2. To make the students to understand the Selection of appropriate technology for the application
3. To make the students to have knowledge on Exposure to RP software packages

UNIT I INTRODUCTION **9 Hours**

Introduction- Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, Classification of RP systems.

UNIT II RP PROCESS-1 **9 Hours**

Principle, process parameters, process details and applications of various RP processes - Stereo lithography systems, Laser Sintering, Fused Deposition Modeling, Laminated Object.

UNIT III RP PROCESS-2 **9 Hours**

Manufacturing, Solid Ground Curing, Laser Engineered Net Shaping, 3D Printing, Laser Melting, Cladding.

UNIT IV RAPID TOOLING **9 Hours**

Rapid Tooling: Indirect rapid tooling Direct rapid tooling , soft tooling Vs hard tooling, Rapid Manufacturing Process Optimization- Factors influencing accuracy, data preparation errors, part building errors, errors in finishing, influence of part build orientation.

UNIT V RP SOFTWARES **9 Hours**

Software for RP: STL files, overview of solid view, magics, mimics, magics communicator, etc., internet based softwares, collaboration tools. RP Technology selection, Decision Making, Life Cycle Assessment of RP processes, Sustainability issues.

TOTAL: 45 HOURS

FURTHER READING / CONTENT BEYOND SYLLABUS / SEMINAR :

1. 3-D Printing
2. Sustainable Manufacturing
3. Advanced Rapid prototyping software

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1 Understand the importance of time compression technologies
CO2 Selection of appropriate technology for the application
CO3 Exposure to RP software packages
CO4 Understand the different rapid tooling process.
CO5 Analyze the rapid prototyping using relevant software.

REFERENCES:

1. Pham D T and Dimov S S, "Rapid Manufacturing", Verlag, 2001.
2. Paul F Jacobs, "Stereo lithography and other RP&M Technologies", SME,1996.
3. Terry Wohlers, "Wohlers Report 2001", Wohlers Associates, 2008.
4. Prasad H and Badrinarayanan, K S, "Rapid Prototyping and Tooling", SPI-Pageturners, Bangalore, India, 2013.

1703MF016	HEAT TREATMENT	L	T	P	C
		3	0	0	3

PREREQUISITE :

Engineering Materials and Metallurgy

COURSE OBJECTIVES:

1. To make the students to have knowledge on identify the effect of heat treatment in alloying elements
2. To make the students to have knowledge on apply surface modification techniques
3. To make the students to have knowledge on find the defects occurring in heat treated parts

UNIT I INTRODUCTION **9 Hours**

Iron - Carbon Equilibrium Diagram: Effect of alloying element on properties of steel and heat treatments. Types and application of heat treatments in manufacturing Industries.

UNIT II TTT PROCESS **9 Hours**

TTT & CCT diagram for steels-Various heating media used for heat treatment, furnaces, Temperature and atmosphere control- Selection of furnace for heat treatment.

UNIT III HEAT TREATMENT PROCESS **9 Hours**

Heat Treatment Processes: Annealing – Normalising, Hardenability studies, Jominy end quench test, Grossman's experiments - Tempering, Austempering and Martempering. Thermomechanical treatments.

UNIT IV SURFACE MODIFICATION TECHNIQUES **9 Hours**

Surface Modification Techniques: Induction hardening, flame hardening, electron beam hardening and Laser beam hardening. Carburising, nitriding, carbonitriding, CVD and PVD processes, Ion implantation.

UNIT V DESIGN FOR HEAT TREATMENT **9 Hours**

Heat Treatment of Non-Ferrous Metals and Specific Alloy steels: Heat treatment of gray irons, white irons (malleabilising) and S.G.irons. Austempering of S.G.Iron. Defects: Defects in heat treated parts, causes and remedy Design for heat treatment.

TOTAL: 45 HOURS

FURTHER READING / CONTENT BEYOND SYLLABUS / SEMINAR :

1. Heat treatment for metal matrix composite.
2. Heat treatment for high temperature application metal.
3. Design for smart material heat treatment.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1 Identify the effect of heat treatment in alloying elements
CO2 Apply surface modification techniques
CO3 Find the defects occurring in heat treated parts
CO4 Understand the different surface modification techniques.
CO5 Design heat treatment for different metals.

REFERENCES:

1. Rajan and Sharma "Heat Treatment Principles and Techniques" – Prentice Hall of India (P) Ltd, New Delhi, 2004.
2. Prabhudev, K H., "Handbook of Heat Treatment of Steels", Tata - McGraw Hill Publishing Co., New Delhi, 2000.
3. VijendraSingh,"Heat Treatment of Metals", Standard Publishers Distributors, Delhi, First edition 1998.
4. American Society for Metals, "Metals Handbook Vol.4", ASM Metals Parks, Ohio, USA, 2001.
5. Karl-Erik Thelning, "Steel and its Heat Treatment", Butterworths London, second edition 1984.
6. Novikov I, "Theory of Heat Treatment of Metals", MIR Publishers, Moscow, 1978.

1703EV017	INDUSTRIAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

PREREQUISITE :

Knowledge on waste water and treatment

COURSE OBJECTIVES:

1. To impart knowledge on the concept and application of Industrial pollution prevention
2. To impart knowledge on the cleaner technologies
3. To educate about the industrial wastewater treatment and residue management.

UNIT I INTRODUCTION **8 Hours**

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents and Bioassay tests – Major issues on water quality management.

UNIT II INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION **8 Hours**

Prevention vis a vis Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy - Source reduction techniques – Periodic Waste Minimisation Assessments – Evaluation of Pollution Prevention Options – Cost benefit analysis – Pay-back period – Implementing & Promoting Pollution Prevention Programs in Industries.

UNIT III INDUSTRIAL WASTEWATER TREATMENT **10 Hours**

Flow and Load Equalisation – Solids Separation – Removal of Fats, Oil & Grease- Neutralisation – Removal of Inorganic Constituents – Precipitation, Heavy metal removal , Nitrogen & Phosphorous removal, Ion exchange, Adsorption, Membrane Filtration, Eletrodialysis & Evaporation – Removal of Organic Constituents – Biological treatment Processes, Chemical Oxidation Processes, Advanced Oxidation processes – Treatability Studies.

UNIT IV WASTEWATER REUSE AND RESIDUAL MANAGEMENT **9 Hours**

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning, dewatering and disposal of sludge – Management of RO rejects.

UNIT V CASE STUDIES **10 Hours**

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Textiles – Tanneries – Pulp and paper – metal finishing – Oil Refining – Pharmaceuticals – Sugar and Distilleries

TOTAL: 45 HOURS

FURTHER READING / CONTENT BEYOND SYLLABUS / SEMINAR :

1. Recent industrial waste management methodologies
2. Advanced treatment techniques

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1 Understand the wastewater monitoring and treatment requirements
CO2 Define the Principles of pollution prevention and mechanism of oxidation processes.
CO3 Suggest the suitable technologies for the treatment of wastewater.
CO4 Discuss about the wastewater characteristics
CO5 Design the treatment systems

REFERENCES:

1. Industrial wastewater management, treatment & disposal, Water Environment
2. Lawrance K.Wang, Yung . Tse Hung, Howard H.Lo and Constantine Yapijakis, " handlook of Industrial and Hazardous waste Treatment", Second Edition, 2004.
3. Metcalf & Eddy/ AECOM, water reuse Issues, Technologies and Applications, The Mc Graw- Hill companies, 2007.
4. Nelson Leonard Nemerow, "industrial waste Treatment", Elsevier, 2007.
5. W.Wesley Eckenfelder, "Industrial Water Pollution Control", Second Edition, Mc Graw Hill, 1989.
6. Paul L. Bishop, „Pollution Prevention: - Fundamentals and Practice", Mc-Graw Hill International, Boston, 2000.