DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS : M. TECH (MANUFACTURING ENGINEERING)
SEMESTER A

IP82011: METAL CUTTING AND MACHINE TOOLS

PERIOD PERWEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
03	00	00	03	-	-	CW	END SEM	SW	END SEM	100
						30	70	-	-	
Note: Each lecture is of one hour duration.										

COURSE OBJECTIVE	To Revise Manufacturing Process I fundamentals, educating students on metal cutting processes and emphasizing machine-related theories. Provide insight into super finishing operations like lapping and honing.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To learn the selection of required processes and working principles of different Machining Processes.
CO 2	To analyze and evaluate the performance of Machining Processes for different Materials
CO 3	To identify Machining Processes for creating desired features for different Materials.
CO 4	To illustrate the machining performance characteristics and analysis for optimization of process performance.
CO 5	To elaborate principle and application of conventional & Abrasive micromachining.

Course Outcomes	PO1	PO2	PO3
CO1	2	2	2
CO2	3	2	2
CO3	2	2	2
CO4	3	2	2
CO5	2	1	1

COURSE ASSESSMENT: Students will be assessed as following:	
Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1

Machining Processes and Machine Tools: Motions in Machine Tools,

a. **Machine Tools Using Single-Point Cutting Tools:** Single-Point Cutting Tools, Lathe Machines, Vertical-Boring Machining (Vertical borer), Horizontal-Boring Machining (Horizontal borer), Shaping Machine (Shaper), Planning Machine (Planer).
b. **Machine Tools Using Multi-Point Cutting Tools:** Multi-Point Cutting Tools, Drilling Machining, Horizontal-Milling Machine, Vertical-Milling Machine, Broaching Machine, and Taps and Dies.
c. **Machines Tools Using Abrasive Wheels:** Abrasive Wheels, Horizontal-Spindle Surface Grinding Machine, Vertical-Spindle Surface Grinding Machine, Cylindrical-Grinding Machine, Internal

	Cylindrical-Grinding Machine, and Centerless Grinding Machines. **d. Machines Tools Using Fine Abrasive Tools for Finishing:** Honing Machines, Lapping Machines.
UNIT 2	**Mechanics of Metal Cutting:** Chipping action; Cutting parameters; Orthogonal and Oblique cutting; Mechanism and Types of chips; Cutting forces and Stresses; Power and Energy; Heat and Temperature; Mechanics of Turning, Drilling and Milling.
UNIT 3	**Cutting Tool Technology, Chip Control and Economics:** Tools Materials, Tool Geometry, and Tool Life; Cutting Fluids; Economics of Metal Cutting Processes; and Surface Roughness.
UNIT 4	**Abrasive Machining- Grinding and Finishing:** Mechanics of Metal Grinding, Grinding Wheel, its specification, and Chip Formation; Grinding Forces and Power; Grinding Temperature; Conventional Abrasive Finishing Processes (CAFP): Honing, Lapping, Buffing, and Superfinishing.
UNIT 5	**Introduction to Conventional Micromachining:** Need and Classification; Process Principles and Applications of Conventional Micromachining, Abrasive Micromachining.

Textbooks:

B.L. Juneja, G. S. Sekhon and Nitin Seth, *Fundamentals of Metal Cutting and Machine Tools*, 2nd Ed., New Age International Publications, Delhi, 2015.

A. Ghosh and A. K. Mallik, *Manufacturing Science*, 2nd Ed., East-West Press Private Limited, 2010.

V. K. Jain, *Introduction to Micromachining*, 2nd Ed., Narosa Publishers, New Delhi, 2009.

Reference Books:

S. Kalpakjian and S.R. Schmid, *Manufacturing Processes for Engineering Materials*, 6th Ed., Pearson Publications, 2016.

Geoffrey Boothroyd and Winston A. Knight, *Fundamentals of Machining and Machine Tools*, 3rd Ed., CRC Press, Taylor & Francis Group, 2013.

G. K. Lal, *Introduction to Machining Science*, 2nd Ed., New Age International Publisher Limited, New Delhi, 2007.

M.P. Groover, *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*; 3rd Ed., Wiley India Pvt. Ltd., New Delhi, 2012

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS : M. TECH (MANUFACTURING ENGINEERING)
SEMESTER A

IP 82012: ADVANCED MACHINING PROCESSES

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	02	00	03	02	00	30	70	40	60	100
Note: Each lecture is of one hour duration.										

COURSE OBJECTIVE	To provide knowledge of modern manufacturing processes such as Ultrasonic machining, Jet Machining, Electrochemical machining, Electro discharge machining processes, and their modifications into hybrid processes
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To learn the fundamentals and working principles of different Advanced Machining Processes.
CO 2	To analyze and evaluate the performance of Advanced Machining Processes for machining of different Advanced Engineering Materials.
CO 3	To identify Advanced Machining Processes for creating desired features in different Advanced Engineering Materials.
CO 4	To illustrate the machining performance characteristics and analysis for optimization of process performance.
CO 5	To analyze and evaluate the Process Principle and applications of Hybrid machining processes.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3
CO1	3	2	0
CO2	3	2	2
CO3	2	2	2
CO4	2	2	2
CO5	2	1	1

COURSE ASSESSMENT : Students will be assessed as following:

Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks, Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1	**Mechanical Energy-based Machining Processes:** Need and Classification of Advanced Machining Processes; Process Principle, Applications, Equipment, Process Analysis and Tool Design of Ultra-Sonic Machining (USM); Jet Machining Processes: Process Principle, Applications, Equipment, Process Analysis of Abrasive Water Jet Machining (AWJM), Abrasive Jet Machining (AJM), and Water Jet Machining (WJM).
UNIT 2	**Chemical Energy-based Machining Processes:** Process Principle, Applications, Equip-

	ment, Process Analysis and Tool Design of Electro-Chemical Machining (ECM); Chemical Machining Processes: Process Principle, Applications, Equipment, Process Parameters of Chemical Milling (CHM), Chemical Engraving (CHE), Chemical Blanking (CHB), and Photochemical Machining (PCM).
UNIT 3	**Thermal Energy-based Machining Processes:** Process Principle, Applications, Equipment, Process Analysis and Tool Design of Electro-Discharge Machining (EDM); Beam Machining Processes: Process Principle, Applications and Equipment for Laser Beam Machining (LBM), Electron Beam Machining (EBM), Ion Beam Machining (IBM), and Plasma Beam Machining (PBM).
UNIT 4	**Hybrid Machining Processes:** Introduction, need, and classification of Hybrid Machining Processes; Process Principle, Applications and Equipment for Combined Machining Processes (Electrochemical Grinding (ECG), Electrochemical Deburring (ECD), Electrochemical Honing (ECH), Electrochemical Superfinishing, Electrical Discharge Diamond Grinding (EDDG), Electrolytic Magnetic Abrasive Machining (EMAM), and Electro-Chemical Discharge Machining (ECDM)) and Assisted Machining Processes (Ultrasonic Assisted EDM and ECM as well as Laser Assisted EDM and ECM).
UNIT 5	**Non-Conventional Finishing and Micromachining:** Need and Classification; Process Principle, Applications and Equipment for Abrasive Flow Finishing (AFF), Magnetic Abrasive Finishing (MAF), Magneto-Rheological Finishing (MRF); Micromachining: Process Principle and Applications of Non-Conventional Micromachining and Combined Micromachining.
Textbooks:	
V. K. Jain, *Advanced Machining Processes*, Allied, New Delhi, 2004.	
P. K. Mishra, *Nonconventional Machining*, Narosa Publishing House, New Delhi, 2014.	
A. Ghosh and A. K. Mallik, *Manufacturing Science*, 2nd Ed., East-West Press Private Limited, 2010.	
P. C. Pandey and H. S. Shan, *Modern Machining Processes*, TMH Publishing Limited, New Delhi, 2008.	
Reference Books:	
Hassan Abdel-Gawad El-Hofy, *Advanced Machining Processes*, McGraw-Hill Companies, USA, 2005.	
V. K. Jain, *Introduction to Micromachining*, 2nd Ed., Narosa Publishers, New Delhi, 2009.	
M.P. Groover, *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*; 3rd Ed., Wiley India Pvt. Ltd., New Delhi, 2012	

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS: M. TECH (MANUFACTURING ENGINEERING)
SEMESTER A

IP 82013: COMPUTER-AIDED MANUFACTURING (CAM)

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	02	00	03	02	00	30	70	40	60	100

Note: Each lecture is of one hour duration.

COURSE OBJECTIVE	To apply knowledge about Computer Aided Quality control and Process Planning Control. Students will be able to design flexible manufacturing cell after carrying out Group technology study and finally creating FMS.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To learn the fundamentals of various control systems and sensing actuation system for NC/CNC machines.
CO 2	To learn and execute the basic NC Codes/Commands to program NC/CNC Machines.
CO 3	To comprehend fundamental knowledge of FMS Systems, Group Technology, and CAPP.
CO 4	To comprehend the fundamental tools & CAM, CIM Wheel integration Technologies, and database management system.
CO 5	To apply the knowledge of CAQC, CAI & CAT for contact and non-contact inspection.

Course Outcomes	PO1	PO2	PO3
CO1	2	1	0
CO2	2	2	2
CO3	2	3	2
CO4	2	1	3
CO5	2	2	2

COURSE ASSESSMENT : Students will be assessed as following:	
Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS	
UNIT 1	**Introduction:** Introduction to Control, Open Loop and Closed Loop Control Systems, Drives and Controls Interpolators for CNC Machine Tools. Numerical Control, Types of CNC Systems. Feedback Devices: Resolvers, Encoders, and Inductosyns; Sensors; Actuation Systems: Hydraulic, Pneumatic and Electromechanical; Computer Control and Adaptive Control System: CNC, DNC and AC.
UNIT 2	**NC/CNC Part Programming:** Components of NC/CNC System, Specification

	of CNC System, Classification of NC/CNC Machines, Tape, Tape Codes and Tape Readers used in NC Machines Constructional Details of CNC Machines, Axis Designation, NC/CNC Tooling. Fundamentals of Manual Part Programming, Types of Format, Word Address Format Manual Part Programming for Drilling, Turning and Milling Operations, Subroutines, Do Loops, Canned Cycles, and Parametric Subroutines. Computer Assisted Part Programming: Need, List of Computer Assisted Programming Languages, and Automated Programmed Tools Language: Its Types of Statement, Command and Programming CAD based CNC Programming using CAM Software.
UNIT 3	**Flexible Manufacturing System (FMS):** Introduction of FMS, Need of FMS, General Considerations for FMS, Types of FMS, Flexibilities, their Measurements, Various Mathematical Techniques for Flexibility Measurements. Computer Aided Process Planning (CAPP): Types of Process Planning System, Advantages of CAPP; Manufacturing Cells, Cellular v/s Flexible Manufacturing, Application of Just-In-Time and Group Technology to FMS.
UNIT 4	**Computer Integrated Manufacturing Systems (CIMS):** Basic Information of CIMS, Hardware and Software Requirements for CIMS, Benefits, Scope and Needs, CIMS Wheel, Elements of CIMS and their Role, Computer Technology and Manufacturing, Database Requirement, Fundamentals of Communication, Data Base Management, Database Models, DBMS Architecture, SQL, Steps to Implement CIM, Its Management, Personnel, Emerging Technologies like Expert Systems, Computer Vision, Lasers in Manufacturing (Machinery and Metrology), Multimedia Communications, etc. CAD/CAM Integration Programming, Post Processors.
UNIT 5	**Computer-Aided Quality Control (CAQC):** Use of Computers in QC, Computer Aided Inspection (CAI): Contact Inspection Methods, Non-Contact Inspection, In-Process-Gauging, Online Inspection and Quality Control, Machine Vision System, Computer Aided Testing (CAT).

Textbooks:

P. Radhakrishan, S. Subramaniyam, *CAD CAM and CIM*, 3rd Ed., New Age International, 2008.

Paul G. Ranky, *Computer Integrated Manufacturing*, Prentice Hall International, 1986.

S. Kant Vajpayee, *Computer Integrated Manufacturing*, Prentice Hall of India, 1995.

Reference Books:

M.P. Groover, *Automation, Production Systems and CIM*, 4th Ed., Pearson Education, 2016.

David Bedworth, *Computer Integrated Design and Manufacturing* Tata McGraw Hill, New Delhi, 1998.

P. Rao and N. Tewari and T. K. Kundra, *Computer Aided Manufacturing*, McGraw Hill Education, New Delhi, 2017.

William W. Luggen, *Flexible Manufacturing Cells and System*, Prentice Hall, England Cliffs, New Jersey, 1991.

T. C. Chang, R. A. Wysk and H. P. Wang, 3rd Ed., *Computer aided Manufacturing*, Pearson, 2008.

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS: M. TECH (MANUFACTURING ENGINEERING)
SEMESTER A

IP 82214: COMPOSITE MATERIALS (Elective-I)

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	00	00	03	00	00	30	70	-	-	100

Note: each period is of one hour duration.

COURSE OBJECTIVE	To impart a comprehensive knowledge of the development and mechanics of composite materials for different advanced engineering applications
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To learn the concept of composite material and its importance over conventional materials.
CO 2	To gain the method of fabrication of different types of composite materials.
CO 3	To learn analyze the different properties of composite materials under different environmental conditions.
CO 4	To learn the mechanical behavior at the macro level of different types of composite materials.
CO 5	To analysis and evaluate the laminated composites under different mechanical loading conditions.

Course Outcomes	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	2	2	2
CO5	2	3	3

COURSE ASSESSMENT : Students will be assessed as following:

Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks, Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1	**Introduction of Composite Material:** classification and use: Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers ,Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential.
UNIT 2	**Composite Material Fabrication Methods:** Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like Lay up process, Spray up process, filament placement process, resin transfer moulding, Vacuum assisted resin transfer moulding, filament winding, compression molding, sheet moulding, Injection Moulding, Extrusion, Blow moulding, rotational moulding, Pultrusion, pre-peg layer etc.

	Manufacturing of Metal Matrix Composites: Layer composites and infiltration method, Manufacturing of Ceramic matrix composites: Hot isostatic processing.
UNIT 3	**Micromechanics:** Fiber volume fraction, micro-mechanical relations, determination of strength and stiffness, Environmental effects-Hygro-thermal behavior.
UNIT 4	**Macromechanics:** Basic stress-strain relationships for anisotropic materials, engineering constants for orthotropic materials, stress-strain relations for a lamina of arbitrary orientation, effective moduli, invariant properties of anorthotropic lamina, special cases of laminate stiffness, laminate strength analysis, the concept of inter-laminar stresses and delamination.
UNIT 5	**Failure Theories and Damage Mechanics:** Failure mechanisms, maximum stress theory, maximum strain theory, Tsai- Hill theory, Tensor polynomial failure criterion, first ply failure theory, Introduction to damage theory based on continuum damage mechanics.
Text Books	
B.D. Agarwal, L.J. Broutman, K. Chandrashekhara, Analysis and Performance of Fiber Composites, Wiley, India.	
P.K. Mallick, Fiber-reinforced Composites Materials, manufacturing, and design, CRC Press	
Reference Books:	
Carl T. Herakovich, Mechanics of fibrous composites, John wiley & sons.	
R. F. Gibson, Principles of Composite Material Mechanics, McGraw Hill Inc.	
R. M. Jones, Mechanics of Composite Materials.	
Stephen W.Tsai and H. Thomas Hahn, Introduction to Composite Material.	
J. N. Reddy and A.V. Krishna Moorty, Composite Structures, Testing, Analysis and Design.	

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS: M. TECH (MANUFACTURING ENGINEERING)

SEMESTER A

ME 82014: FINITE ELEMENT METHOD

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
04	00	00	03	-	-	30	70	-	-	100

COURSE OBJECTIVE	The course is designed to impart computer aided skill for applying different DOE based techniques to solve real life engineering science problems.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	Classify a given problem on the basis of its dimensionality as 1- D, 2-D, or 3-D, time-dependence as Static or Dynamic, Linear or Non-linear. Students will also understand deriving governing differential equations for axial bar problems.
CO 2	Derive the shape functions and element level governing equations for solving axial bar problem. They will also understand criterion to select proper number of elements in finite element analysis.
CO 3	Solve beam problems by finite element method and will also learn to extend bar and beam elements to solve truss and frame problems.
CO 4	Write shape functions for lower and higher order two dimensional and quadrilateral elements and will also learn writing governing differential equations for two dimensional problems.
CO 5	Write equations of motion of dynamic systems using finite element method. They will also learn solving eigenvalue and force vibration problem using finite element method.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1

COURSE ASSESSMENT : Students will be assessed as following:

Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1	Introduction to approximate methods of solving mathematical models of physical systems. Method of weighted residuals and variational approach for solving differential equations. Galerkin method. Weak form of weighted residual statement.
UNIT 2	Basic aspects of the finite element method. Principle of minimum potential energy.

	Rayleigh-Ritz method. Introduction to finite element modelling of one dimensional problems in statics. Finite element for bar problems, Linear and quadratic shape functions. Convergence criterion.
UNIT 3	Finite element formulation for truss and frame problems. Formulation of Beam problems. Numerical integration, Coordinate transformation.
UNIT 4	Plane stress and plane strain problems, Axisymmetric Formulation, Two dimensional problems using constant strain triangles and higher order elements, iso-parametric formulation.
UNIT 5	Dynamic analysis, Equations of motion, Mass Matrices, Free vibration analysis, Natural frequencies of longitudinal, transverse and torsional vibration, Introduction to transient field problems.
Text Books	
Textbook of Finite Element Analysis, P. Seshu, Eastern Economy Edition	
Finite Elements in Engineering, Chandrupatla and Belegundu, Prentice Hall India	
Reference Books:	
Finite Element Analysis, C S Krishnamoorthy, Tata McGraw-Hill	
Finite Element Method, J. N. Reddy, Tata Mc Graw-Hill	

IP 82451: Computer Aided Manufacturing Lab

List of Experiments

1. 2D drawing creation in Auto CAD
2. Dimensioning
3. Blocks and Layers
4. Surface Modeling
5. Solid Modeling using CSG
6. Paper Space layouts
7. Auto LISP Programming Interface
8. Automated drawing generation using Auto LISP programming interface,
9. Customizing AutoCAD
10. CNC Programming for CNC lathe Mirac
11. CNC Programming for CNC milling Triac
12. Robot Programming for Move master for pick and place and operations and
1. interfacing with machine work
13. FMS Configuration, Programming and Simulation

Books & References Recommended:

1. Mastering AutoCAD2000, George Omura
2. ABC of Auto LISP, George Omura
3. Robot RVM1 Movemaster Manual
4. FMS Manual
5. CNC Programming Manual TRIAC
6. CNC Programming Manual MIRAC

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IP 82452: Advanced Machining Processes Lab

List of Experiments

1. To study EDM machine and sinking hole on a specimen using EDM process.
2. To study ECM machine and creating hole on a specimen using ECM process.
3. To study ECDM experimental setup and sinking hole on Pyrex Glass specimen using Sinking-ECDM process.
4. To Compare hole sinking and drilling ECDM processes by creating hole on Pyrex Glass Specimen.
5. To create different profile of grooves on a specimen using EDM machine.
6. To study the different variants of EDM process.
7. To compare EDM process with Near dry EDM process.
8. To study Micro-EDM machine and drilling hole on a specimen using Micro-EDM.
9. To study Ultrasonic Machine and making hole on a specimen using USM process.
10. To compare hole sinking and drilling USM processes by creating hole on a Specimen of hard and brittle material.

Books & References Recommended:

1. Hassan Abdel-Gawad El-Hofy, *Advanced Machining Processes*, McGraw-Hill Companies, USA, 2005.
2. V. K. Jain, *Advanced Machining Processes,* Allied, New Delhi, 2004.
3. P. K. Mishra, *Nonconventional Machining*, Narosa Publishing House, New Delhi, 2014.
4. A. Ghosh and A. K. Mallik, *Manufacturing Science,* 2nd Ed., East-West Press Private Limited, 2010.
5. V. K. Jain, *Introduction to Micromachining*, 2nd Ed., Narosa Publishers, New Delhi, 2009.

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ME 82453: Finite Element Method Lab

List of Experiments

1. To solve Finite Element Equations using Gauss Elimination Method using MATLAB Programming
2. To prepare solid modal given geometry and perform meshing of the solid modal
3. To perform stress analysis of a given structural member with given boundary conditions
4. To perform thermal stress analysis of a given structural member with given boundary conditions

Books & References Recommended:

1. Amos Gilat, MATLAB an Introduction with Applications, 4th Ed., Wiley India Edition, 2014.
2. Young W. Kwon and Hyochoong Bang, Finite Element Method using MATLAB, 2nd Ed., CRC Press, 2000.
3. J. N. Reddy, *An Introduction to The Finite Element Method*; 3rd Ed., Tata McGraw-Hill Publishing Company, New Delhi, 2006.
4. S.S. Rao, *Finite Element Method in Engineering*, Elsevier Pergaman Press, 1997.

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IP 82501: RAPID PROTOTYPING AND TOOLING

PERIOD PERWEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
03	00	00	03	-	-	CW	END SEM	SW	END SEM	100
						30	70	-	-	
Note: Each lecture is of one hour duration.										

COURSE OBJECTIVE	Course is designed to impart the knowledge and skill of rapid prototyping processes for creating desired features with requisite accuracy.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To gain the basic concepts of different types of additive manufacturing processes along with various rapid prototyping system.
CO 2	To develop proficiency in the role of additive manufacturing and rapid prototyping in product design and development.
CO 3	To develop proficiency in the process planning for rapid prototyping and become familiar with the entire rapid prototyping process, from conceptualization to final prototype production.
CO 4	To gain the knowledge of the accuracy, surface finish, stresses induced in the metallic and non-metallic additive manufacturing.
CO 5	To develop concepts of the different type of rapid tooling techniques.

Course Outcomes	PO1	PO2	PO3
CO1	2	2	1
CO2	2	2	2
CO3	3	2	2
CO4	2	1	2
CO5	2	1	1

COURSE ASSESSMENT : Students will be assessed as following:	
Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)
COURSE CONTENTS	
UNIT 1	Introduction: Classification of Additive Manufacturing Processes, Additive Manufacturing Based Rapid Prototyping Systems: Stereo-Lithography, Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), 3-D Printing, LENS etc.
UNIT 2	Role of Additive Manufacturing and Rapid Prototyping in Product Design and Development; Solid Modeling Techniques for Additive Manufacturing with Comparison, Advantages andDisadvantages.

UNIT 3	Process Planning for Rapid Prototyping, STL File Generation Defects in STL Files and Repairing Algorithms, Slicing and Various Slicing Procedures.
UNIT 4	Accuracy Issues in Additive Manufacturing, Properties of Metallic and Non-Metallic Additive Manufactured Surfaces, Stress Induced in Additive Manufacturing Processes, Surface Roughness Problem in Rapid Prototyping, Part Deposition Orientation and Issues Like Accuracy, Surface Finish, Build Time, Support Structure, Cost etc.
UNIT 5	Rapid Tooling Techniques such as Laminated Metallic Tooling, Direct Metal Laser Sintering,Vacuum Casting etc.

Textbooks:

C. K. Chua, K. F. Leong, and C. S. Lim, *Rapid prototyping: Principles and applications*, 3rdEd., World Scientific Publishers, 2010.

A. Gebhardt, *Rapid prototyping*, Hanser Gardener Publications, 2003.

Chua Chee Kai and Leong Kah Fai, *Rapid Prototyping: Principles & Applications*, WorldScientific, 2003.

Ian Gibson, David W Rosen, Brent Stucker, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer, 2010.

Reference Books:

Ali K. Kamrani, Emand Abou el Nasr, *Rapid Prototyping: Theory & Practice*, Springer, 2006.

D.T. Pham, S.S. Dimov, *Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling*, Springer, 2001.

Andreas Gebhardt, *Understanding Additive Manufacturing: Rapid Prototyping, RapidTooling, Rapid Manufacturing*, Hanser Publishers, 2011.

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS : M. TECH (MANUFACTURING ENGINEERING)

SEMESTER B

IP 82502: CASTING AND FORMING PROCESSES

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	00	00	03	-	-	30	70	-	-	100

Note: Each lecture is of one hour duration.

COURSE OBJECTIVE	It is aimed to provide understanding casting and forming processes andability to analyse the process performance.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To gain the knowledge of the casting and solidification process and evaluate the fluidity of metal and solidification of different shape casting.
CO 2	To develop the concept of riser and gating design along with the Application of Geometrical Programming and review of casting design.
CO 3	To understand the various moulding processes, Inspection, and advance casting techniques.
CO 4	To analyze the different forming processes along with yield criteria of metals and theories of failure and analysis of metal working processes.
CO 5	To gain the knowledge of Mechanics of Forming Processes such as rolling, forging, drawing, extrusion, bending, punching, and blanking along with their analysis and evaluation and various advanced metal forming processes.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3
CO1	3	2	2
CO2	3	2	2
CO3	2	1	2
CO4	2	2	2
CO5	2	1	2

COURSE ASSESSMENT : Students will be assessed as following:

Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks, Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1	**Introduction of Metal Casting:** Classification of Casting Processes, Solidification: Solidification of Pure Metals and Al1oys, Nucleation and Growth in Alloys, Solidification of Actual Castings, Progressive and Directional Solidification, Centerline Feeding Resistance, Rate of Solidification, Chvorinov's Rule, Electrical Analogy of Solidification Problem; Fluidity- Measurement of Fluidity, Effects of Various Parameters on Fluidity.
UNIT 2	**Risering and Gating System:** Riser Design, Risering Curves, NRL Method of Riser Design, Feeding Distance, Risering of Complex Casting, Risering of Alloys Other than Steel, Recent Developments in

	Riser Design by the Application of Geometrical Programming; Gating System Design and their Characteristics, the Effects of Gates on Aspiration, Turbulence and Dross Trap, Recent Trends; Pattern and Casting Design: Pattern Design, Recent Developments in Pattern Design, Materials and Construction; Casting Design Considerations- Review of Casting Design, Recent Trends.
UNIT 3	**Moulding, Inspections and Advanced Casting Processes:** Low Pressure and Ferrous Die Casting, High Pressure Moulding, Full Mould Process, Flaskless Moulding, Hot andCold Box Moulding, Ceramic Shell Moulding, Casting Defects: Residual Stresses, Hot Tears and Cracks, Stress Relief, Defects and their Causes and Remedies, Parameters Affecting Surface Finish, Inspections: Testing of Sand, Mulling Index, Moldability Index, Compactability; Deformability; Review of X-Ray and Gamma Ray Radiography, Magnetic Particle, Die Penetrant and Ultrasonic Inspection etc.; Advanced Casting Processes: Evaporative Pattern Casting, Vacuum Mould Casting, Investment Casting Process, Continuous Casting, Squeeze Casting, Ceramic Shell Casting.
UNIT 4	**Introduction of Forming and Process analysis:** Stress/Strain, Strain-Rate, Yield Criteria of Metals and Theories of Failure, C1assification of Metal Forming, Formability, Theories of Friction and Lubrication; Process Analysis: Analysis of Metal Working Processes Such as Slipline Field Theory, Upper Bound Solution, and Stab Methods.
UNIT 5	**Mechanics of Forming Processes: Rolling**: Determination of Rolling Pressure, Roll Separating Force, Driving Torque and Power, and Power Loss in Bearings; **Forging:** Determination of Forces in Strip Forging and Disc Forging; **Drawing**- Determination of Force and Power, Determination of Maximum Allowable Reduction; Deep Drawing Force Analysis, Analysis of Tube Drawing Process with Fixed and Moving Mandrel, Tandem Tube Drawing; **Extrusion:** Determination of Work Load from Stress Analysis and Energy Consideration, Power Loss, Hydrostatic Extrusion; **Bending:** Determination of Work Load and Spring Back; **Punching and Blanking:** Mode of Metal Deformation and Failure, Two-Dimensional Deformation Model and Fracture Analysis, Determination of Working Force. **Advanced Metal Forming Processes:** High Energy Rate Forming (HERF), Electro-Magnetic Forming, Explosive Forming, Electro-Hydraulic Forming, Stretch Forming, And Contour Roll Forming.

Textbooks:

R.W. Heine, C.R. Loper, and P.C. Rosenthal, *Principles of Metal Casting*, TMH, New Delhi.

P. L. Jain, *Principles of Foundry Technology*, TMH, New Delhi.

A. Ghosh and A. K. Mallik, *Manufacturing Science*, 2nd Ed., East-West Press Private Limited,2010.

Reference Books:

S. Kalpakjian and S.R. Schmid, *Manufacturing Processes for Engineering Materials*, 6th Ed.,Pearson Publications, 2016.

M.P. Groover, *Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*; 3rdEd., Wiley India Pvt. Ltd., New Delhi, 2012.

B. Avitzur, *Metal Forming: Processes and Analysis*, McGraw Hill Book Company, UK.

R. H. Wagoner and J. L. Chenot, *Metal Forming Analysis*, Cambridge University Press, NewYork, U.S.A.

IP 82503: WELDING TECHNOLOGY

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	00	00	03	-	-	30	70	-	-	100

Note: Each lecture is of one hour duration.

COURSE OBJECTIVE	The course is aimed to provide concept of different welding processes and ability to analyse the process performance.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To comprehend the evolution and classification of welding processes along with various welding power sources and types of weld joints with various weld symbols.
CO 2	To gain the knowledge of different types of arc welding processes and their working principles and mechanisms.
CO 3	To comprehend and analyze the resistance welding processes and friction welding techniques along with different advance welding processes.
CO 4	To develop the proficiency in the different weld joint testing techniques such as destructive and non-destructive.
CO 5	To develop the knowledge of weldability of metals, Heat Affected Zone (HAZ), various types of reactions in welding and their effect, weldability of different metals such as steel, cast iron, aluminium alloys etc.

Course Outcomes	PO1	PO2	PO3
CO1	2	1	2
CO2	3	2	2
CO3	2	1	1
CO4	2	2	2
CO5	2	2	3

COURSE ASSESSMENT : Students will be assessed as following:	
Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS	
UNIT 1	**Introduction:** Evolution of Welding; Classification of Welding Processes; Heat Sources and Shielding Methods, Physics of Welding, and Selection of Welding Power Sources, Type of Welds and Weld Joints; Description of Welds: Terminology, Definitions and Weld Symbols; Edge Preparation.
UNIT 2	**Arc Welding Processes:** Consumable Electrode Welding Processes; Manual Metal Arc (MMA) Welding; Gas Metal Arc Welding; Pulsed MIG Welding; Submerged Arc Welding, Significance of Flux-Metal Combination; Electroslag Welding, Non-consumable electrode welding; Gas Tungsten Arc Welding; Plasma Arc Welding; Transferred and Non-Transferred Plasma Arc Welding.

UNIT 3	**Resistance Welding Processes:** Introduction to Resistance welding, Arc generation, Types of resistance welding; Spot welding, Seam welding, Stud welding, Applications of resistance welding. **Friction Welding:** Friction Welding Process Variables, Welding of Similar and Dissimilar Materials, Friction Welding of Materials With Inter Layer. **Friction Stir Welding:** Processes Parameters, Tool Geometry, Welding of Aluminium Alloys, Friction Stir Welding of Aluminium Alloys and Magnesium Alloys, Micro-structure Analysis. **Advanced Welding Processes:** Details of Electron Beam Welding (EBW), Laser Beam Welding (LBW), Ultrasonic Welding (USW)
UNIT 4	**Testing and Inspection of Weld Joints:** Chemical Tests; Metallographic Tests; Hardness Tests; Mechanical Test For Groove and Fillet Welds-Full Section, Reduced Section and All-Weld- Metal Tensile Tests, Root, Face and Side Bend Tests, Fillet Weld Break Tests, Creep & Fatigue Testing; Non-Destructive Testing of Weldments; Visual Inspection; Dye-Penetrant Inspection; Magnetic Particle Inspection; Ultrasonic Inspection Principle of Ultrasonic Testing, Radio-graphic Inspection- Principle of Radiography, X-Ray Tubes, Gamma-Ray Sources.
UNIT 5	**Weldability of Metals:** Solidification of Weld Metal; Heat Affected Zone (HAZ), Factors Affecting Properties of HAZ; Gas-Metal, Slag-Metal and Solid State Reactions in Welding and their Influence on Soundness of Weld Joint; Definition of Weldability, Factor Affecting the Weldability of Steel Carbon Equivalent; Weldability of Steel, Cast Iron and Aluminium Alloys of Commercial Importance, Failure Analysis of Welded Joints.
Textbooks:	
V. M. Radhakrishnan, *Welding Technology and Design*, New Age International Pvt. Ltd.,2008.	
R. S. Parmar, *Welding Engineering and Technology*, Khanna Publishers, 2005.	
Reference Books:	
Lancaster, *The Metallurgy of Welding*, 6th Ed., William Andrew Publishing, NY, 1999.	
Robert W. Messler Jr., *Principles of Welding: Processes, Physics, Chemistry, and Metallurgy*,1st Ed., Wiley VCH, 1999.	
S. Kou, *Welding Metallurgy*, Wiley India Edition, 2005.	
S. V. Nadkarni, *Modern Welding Technology*, Oxford IBH Publishers, 1996.	

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS : M. TECH (MANUFACTURING ENGINEERING)

SEMESTER B

ME 82504: MATERIALS AND METALLURGY

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	00	00	03	-	-	30	70	-	-	100

Note: each period is of one hour duration.

COURSE OBJECTIVE	The course is aimed to impart the structural concept of engineering materials and their metallurgical processing used for improvement of material's properties.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To comprehend the classification and selection of engineering materials and different crystalline and non-crystalline structures of Materials and their crystal structure.
CO 2	To analyze the different types of phase diagram, nucleation kinetics and effect of alloyingelements.
CO 3	To gain the knowledge of different types of heat treatment techniques and their applications.
CO 4	To develop proficiency in advance materials, shape memory alloys, composites, and its applications along with their mechanical properties and thermal analysis.
CO 5	To comprehend the various extractive metallurgy such as Pyro-Metallurgy, Hydrometallurgy, and Electrometallurgy.

Course Outcomes	PO1	PO2	PO3
CO1	2	2	1
CO2	2	1	2
CO3	2	2	3
CO4	3	2	2
CO5	3	2	3

COURSE ASSESSMENT : Students will be assessed as following:	
Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks, Quiz: 5 Marks, and Regularity: 5 Marks)
COURSE CONTENTS	
UNIT 1	**Introduction to Structure of Materials**: Classification and Selection of Engineering Materials; Primary and Secondary Bonds; Crystalline and Non-crystalline materials: Crystal Structure, Space Lattice, Unit Cell, Crystal Systems, Atomic Packing Factor, Co-Ordination Numbers, Crystal Structure for Metallic Elements, Crystal Directions and Planes, Miller Indices, Stacking Sequence in HCP & FCC, Crystal Defects and Non-crystalline Structure; Mechanisms of Plastic Deformation, Slip and Twinning, Cold, Warm and Hot Working of Metals, Strain Hardening.
UNIT 2	**Phase Changes and Phase Diagrams:** Types of Phase Changes, Diffusion in Solids, Nucleation and Growth Kinetics, Solidification, Pearlitic, Martensitic and Bainitic Transformation; Recovery, Recrystallization and Grain Growth; Solid Solutions, Solubility Limit; Effect of Alloy Elements on Phase Diagram, Phase Rule, Binary Phase Diagrams, Isomorphous System, Intermediate Phases, Intermetallic Compounds, Iron-Iron Carbide Phase Diagram.

UNIT 3	**Heat Treatment:** Heat Treatment of Steels, TTT Diagram, CCT Diagram; Annealing, Normalizing, Hardening and Tempering, Austempering, Martempering, Hardenability, Precipitation and Age Hardening, Case Hardening, Carburizing, Nitriding, Cyaniding, Carbonitriding, Flame & Induction Hardening, Vacuum & Plasma Hardening.
UNIT 4	**Advanced Material and Tools:** Smart Materials Exhibiting Ferroelectric, Piezoelectric, Optoelectric, Semiconducting Behavior, Lasers and Optical Fibres, Photoconductivity and Superconductivity, Nano Materials, Biomaterials, Superalloys, Bearing alloys, Shape Memory Alloys, Composites and its Applications: MMCs, CMCs & PMCs; Metallography (Optical, TEM, and SEM), X Ray Diffraction, Mechanical Properties, Thermal analysis.
UNIT 5	**Extractive Metallurgy:** General Methods of Extraction, Pyro-Metallurgy; Calcinations, Roasting and Smelting, Hydrometallurgy; Leaching, Solvent Extraction, Ion Exchange, Precipitation, and Electrometallurgy; Electrolysis and Electro-Refining.

Text Books

S. L. Kakani and Amit Kakani, Material Science, New Age International Pvt. Ltd., New Delhi,2004.

A. Ghosh and H. S. Ray, *Principles of Extractive Metallurgy*, 2nd Ed., New Age International,1991.

S.H. Avner, *Introduction to Physical Metallurgy*, 2nd Ed., McGraw Hill Book Company, 2017.

V. Raghavan, *Materials Science and Engineering*, 6th Ed., Prentice Hall of India Pvt. Ltd.,2015.

Reference Books:

Williams D Callister, *Material Science and Engineering*, 2nd Ed., Wiley India Pvt Ltd, RevisedIndian Edition 2014.

V. Raghavan, *Physical Metallurgy: Principles and Practice*, 3rd Ed., Prentice Hall of India Pvt.Ltd., 2016.

R. E. Small Man and A. H. W Ngan, *Physical Metallurgy and Advanced Materials*, 7th Ed.,Butterworth-Heinemann, 2007.

U. C. Jindal, *Material Science and Metallurgy*, Dorling Kindesley Pearson Education, 2012.

B. K. Agarwal, *Introduction to Engineering Materials*, 1st Ed., TMH, New Delhi, 2007.

DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

SHRI G S INSTITUTE OF TECHNOLOGY AND SCIENCE INDORE

SYLLABUS : M. TECH (MANUFACTURING ENGINEERING)

SEMESTER B

Semester- A(Elective-I)

IP 82201: Experimental Design, Data Analysis and Quality Control

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	00	00	03	-	-	30	70	-	-	100

COURSE OBJECTIVE	The course is designed to impart computer aided skill for applying different DOE based techniques to solve real life engineering science problems.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To gain knowledge of the basic concepts of statistical techniques and different statistical distributions.
CO 2	To apply and design the factorial and experimental designs for various conditions and comprehend the importance of studying factor effects and interactions.
CO 3	To analyze the different Interpretation Methods using different statistical techniques, ANOVA, regression analysis, hypothesis testing etc.
CO 4	To apply the various response surface methodologies and experimental designs for fitting response surfaces.
CO 5	To develop the proficiency in quality of experimental design.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3
CO1	3	1	2
CO2	2	2	2
CO3	3	1	2
CO4	2	1	2
CO5	2	2	3

COURSE ASSESSMENT : Students will be assessed as following:

Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1	**Introduction and Basic Statistical Concepts:** Strategy of Experimentation, Typical applications of Experimental design, Basic Principles: Randomisation, Repetition, Replication,Blocking, and Confounding; Guidelines for Designing Experiments; Concepts of Random Variable, Probability, Density Function, Cumulative Distribution Function; Sample and Population; Measure of Central Tendency: Mean Median, Mode, Standard Deviation, Variance, and Measures of Variability; Concept of Confidence Level; Statistical Distributions: Poisson, Gauss, Normal, Log Normal, & Weibull Distributions and other Continuous Probability Distributions (t-Distribution, Chi-squared Distribution, & F-Probability Distribution); Hypothesis Testing, Probability Plots, Choice of Sample Size.

UNIT 2	**Experimental Design:** Classical Experiments, Terminology: Factors, Levels, Interactions, Treatment Combination; Completely Randomised Design, Randomised Block Design, Latin Square Designs; Factorial Experimental Designs, Two-level Experimental Designs for Two Factors & Three Factors; Three-level Experimental Designs for Two Factors & Three Factors, Factor Effects, Factor Interactions, Fractional Factorial Design, Saturated Designs, Central Composite Designs.
UNIT 3	**Analysis and Interpretation Methods:** Measures of Variability, Ranking Method, Column Effect Method & Plotting Method, Analysis of Variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Fitting Regression Models: Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of New Response Observations, Regression Model Diagnostics, Testing for Lack of Fit, and Model Adequacy Checking.
UNIT 4	**Response Surface Methods and Designs:** Introduction to Response Surface Methodology, The Method of Steepest Ascent, Analysis of a First & Second Order Response Surfaces, Experimental Designs for Fitting Response Surfaces: Designs for Fitting the First & Second Order Models.
UNIT 5	**Quality by Experimental Design:** Quality, Western and Taguchi's Quality Philosophy, Elements of Cost, Noise Factors Causes of Variation, Quadratic Loss Function & Variations ofQuadratic Loss Function, Linear graphs and Interaction assignment, Types of Orthogonal Arrays, Selection of Standard Orthogonal Arrays, Evaluation of Sensitivity to Noise, Signal to Noise Ratios for Static & Dynamic Problems; Robust Design: Steps in Robust Design, Parameter Design and Tolerance Design, Reliability Improvement through Experiments.

Text Books

Montgomery, D. C., *Design and Analysis of Experiments*. 8th Ed., John Wiley and Sons, Inc., Hoboken, New Jersey, USA, 2013.

Madhav S. Phadke, *Quality Engineering using Robust Design*, 1st Ed., Pearson Education, 2008.

Sheldon M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, 4th Ed., Elsevier, 2009.

Reference Books:

Dharmaraja Selvamuthu and Dipayan Das, *Introduction to Statistical Methods, Design ofExperiments and Statistical Quality Control*, Springer Nature Singapore Pte Ltd., 2018.

A. M. Dean and Voss D. T., *Design and Analysis of Experiments*, 2nd Ed., Springer International Publishing, 2017.

Ranjit K. Roy, *Design of Experiments using the Taguchi Approach: 16 Steps to Product and Process Improvement*, John Wiley & Sons, 2001.

Semester- B(Elective-II)
ME 82701: MECHATRONICS AND AUTOMATION

PERIOD PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	Tu	T	P	Tu	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
03	00	00	03	-	-	30	70	-	-	100

COURSE OBJECTIVE	It is aimed to provide fundamental knowledge of mechatronics and differentcontrolling devices used in industrial automation.
COURSE OUTCOMES	On successful completion of the course, the student should be able-
CO 1	To comprehend the basics of electronics and place of mechatronics in manufacturing, products, and design.
CO 2	To develop the proficiency in the different types of feedback devices such as sensors and transducers.
CO 3	To gain the knowledge of various microprocessor and micro-controllers.
CO 4	To comprehend the different types of electro-mechanical systems such as motors, bearings, cams etc.
CO 5	To gain the knowledge of different types of electro-hydraulic and electro-pneumatics systems.

CO-PO Mapping

Course Outcomes	PO1	PO2	PO3
CO1	2	2	1
CO2	2	1	1
CO3	2	2	2
CO4	2	1	3
CO5	2	2	1

COURSE ASSESSMENT : Students will be assessed as following:

Theory paper	End Semester Exam: 70 Marks
	Continuous assessment: 30 Marks (Two mid-term tests:15 Marks, Assignment:5 Marks,Quiz: 5 Marks, and Regularity: 5 Marks)

COURSE CONTENTS

UNIT 1	**Introduction:** Definition of mechatronics, Mechatronics in Manufacturing, Products and Design, Review of Fundamentals of Electronics, Open Loop and Closed Loop Control Systems.
UNIT 2	**Mechatronics Elements:** Feedback Devices: Introduction of Sensors and Transducers, Performance Terminology, Displacement, Position and Proximity, Velocity and Motion, Fluid Pressure, Temperature Sensors, Light Sensors, Selection of Sensors, Micro-Sensors, Signal Processing, Servo Systems; Data Conversion Devices, Signal Processing Devices, Relays, Contactors and Timers.
UNIT 3	**Processors /Controllers:** Microprocessors, Micro-controllers, PID Controllers and PLCs.

UNIT 4	**Electro-Mechanical System:** Drives and Their Controlling: AC Motors, DC Motors, Stepper Motors, Servo Motors; Ball Screws, Linear Motion Bearings, Cams, Systems Controlled by Camshafts, Electronic Cams, Indexing Mechanisms, Tool Magazines, and Transfer Systems.
UNIT 5	**Electro-Hydraulic System and Electro-Pneumatic System:** Electro-Hydraulic System: Hydraulic Systems: Flow, Pressure and Direction Control Valves, Actuators, and Supporting Elements, Hydraulic Power Packs, Pumps, Design of Hydraulic Circuits; Electro-Pneumatic System: Pneumatics: Production, Distribution and Conditioning of Compressed Air, SystemComponents and Graphic Representations, Design of Systems.

Text Books

W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, 5th Ed., Pearson Publishers, 2011.

Alciatore and Histand, *Introduction to Mechatronics & Measurement Systems*, 4th Ed., McGraw Hill Education, 2017.

S. R. Deb and Sankha Deb, *Robotics Technology and Flexible Automation*, 2nd Ed., TataMcGraw-Hill, New Delhi, 2017.

Reference Books:

Thomas O. Boucher, *Computer Automation in Manufacturing - An Introduction*, Springer,1996.

HMT Ltd., *Mechatronics*, Tata Mcgraw-Hill, New Delhi, 2017.

Lawrence J. Kamm, *Understanding Electro-Mechanical Engineering, an Introduction toMechatronics*, Wiley-Blackwell, 2015.

P. K. Ghosh and P.R. Sridhar, *Introduction to Microprocessors for Engineers and Scientists*,(0000 to 8085)", 2nd Ed., Prentice Hall, 2004.

IP 82851: Virtual Prototyping and Manufacturing Simulation Lab

List of Experiments

1. To Study Rapid Prototyping and Tooling
2. To Study Layered Manufacturing (LM) Processes
3. To Study Laminated Object Manufacturing (LOM)
4. To Study conversion of CAD to STL file
5. To Study and demonstration of 3D printing of a given object

Books & References Recommended:

1. C. K. Chua, K. F. Leong, and C. S. Lim, *Rapid prototyping: Principles and applications*, 3rd Ed., World Scientific Publishers, 2010.
2. A. Gebhardt, *Rapid prototyping*, Hanser Gardener Publications, 2003.
3. Chua Chee Kai and Leong Kah Fai, *Rapid Prototyping: Principles & Applications*, World Scientific, 2003.
4. Ian Gibson, David W Rosen, Brent Stucker, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer, 2010.
5. Ali K. Kamrani, Emand Abou el Nasr, *Rapid Prototyping: Theory & Practice*, Springer, 2006.

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IP 82852: Welding Technology Lab

List of Experiments

1. To prepare Lap & Butt Joint using ARC Welding as per given drawing
2. To prepare Lap Joint using Spot Welding for given specimens
3. To prepare Lap & Butt Joint using TIG Welding as per given drawing
4. To prepare Lap & Butt Joint using MIG Welding as per given drawing
5. To prepare Butt Joint using Brazing for given specimens

Books & References Recommended:

1. V. M. Radhakrishnan, *Welding Technology and Design*, New Age International Pvt. Ltd., 2008.
2. S. V. Nadkarni, *Modern Welding Technology*, Oxford IBH Publishers, 1996.
3. R. S. Parmar, *Welding Engineering and Technology*, Khanna Publishers, 2005.

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