VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech **Manufacturing Science & Engineering (MSE)**

(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M.Tech Manufacturing Science & Engineering (MSE)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	20MSE11	Mathematical Methods In Engineering	03	--	02	03	40	60	100	4
2	PCC	20MSE12	Advanced Foundry Technology	03	--	02	03	40	60	100	4
3	PCC	20MSE13	Advanced Engineering Materials	03	--	02	03	40	60	100	4
4	PCC	20MSE14	Advanced Joining Process	03	--	02	03	40	60	100	4
5	PCC	20MSE15	Computer Integrated Manufacturing & Automation	03	--	02	03	40	60	100	4
6	PCC	20MSEL16	Laboratory – I	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	01	--	02	03	40	60	100	2
			TOTAL	**17**	**04**	**12**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.
(iii) Two credit courses are designed for 25 hours Teaching – Learning process.

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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Seminar	Skill Development Activities	Duration in hours	CIE Marks		Total Marks	
				L	P	SDA					
1	PCC	20MSE21	Theory of Metal Cutting	03	--	02	03	40	60	100	4
2	PCC	20MSE22	Theory of Metal Forming	03	--	02	03	40	60	100	4
3	PCC	20MSE23	Advanced Processing of Materials	03	--	02	03	40	60	100	4
4	PEC	20MSE24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20MSE25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20MSEL26	Laboratory – II	--	04	--	03	40	60	100	2
7	PCC	20MSE27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20MSE24X	**Course title**	**Course Code under 20MSE25X**	**Course title**
20MSE241	Non Destructive Testing	20MSE251	Micromachining Processes
20MSE242	Rapid Prototyping	20MSE252	Non Traditional Machining
20MSE243	Finite Element Methods	20MSE253	Surface Treatment and Finishing
20MSE244	Simulation & Modelling of Manufacturing Systems	20MSE254	Industrial Design and Ergonomics

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini–Project/ Internship	Skill Development activities	Duration in hours	CIE Marks		Total Marks	
				L	P	SDA					
1	PCC	20MSE31	Nano Technology	03	--	02	03	40	60	100	4
2	PEC	20MSE32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20MSE33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20MSE34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20MSE35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20MSEI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: PCC: Professional core, PEC: Professional Elective.

Professional elective 3		**Professional elective 4**	
Course Code under	**Course title**	**Course Code under**	**Course title**
20MSE321	Industrial Robotics	20MSE331	Composite Materials
20MSE322	Tool Design	20MSE332	Agile Manufacturing
20MSE323	Smart Materials	20MSE333	Operations Management
20MSE324	Precision Engineering	20MSE334	Quality and reliability engineering

Note:

1. Project Work Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

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IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	20MSE41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Work Phase-2:

CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and performance in Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

MATHEMATICAL METHODS IN ENGG. (common to MPT, MPE, MPD, MEM, MPM, MPY, & MSE)			
Course Code	**20MSE11**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Errors and Simple Mathematical modeling: Error definition, round off errors and truncation errors. Mathematical modeling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.

Engineering Applications on :

i) Deflection of Beams
ii) Whirling of shafts
iii) Terminal velocity of a freely falling body

(RBT Levels: L1 & L2) (Text Book:1) **10Hrs**

Module-2

System of Linear Algebraic Equations And Eigen Value Problems: Gauss-Jordan Method, Cholesky Method, Partition method, Givens method for symmetric matrices, (RBT Levels: L1 & L2) (Text Book:3) **10Hrs**

Module-3

Roots of Equations: Muller's method , Graeffe's roots squaring method.

Numerical solutions of ordinary differential equations: Introduction, Picard`s method of successive approximation, first order simultaneous equations by Picard`s & Runge Kutta methods. & second order equations by Picard`s & Runge Kutta methods. (RBT Levels: L2 & L3) (Text Book:3) **10Hrs**

Module-4

Partial Differential Equations: Numerical solution of one dimensional wave equation, Heat equation,(Schmidt`s explicit formula)& Laplace equation(Gauss-Seidel process) by finite difference schemes. Illustrative examples on each method, (RBT Levels: L2 & L3) (Text Book:2). **10Hrs**

Module-5

Sampling theory: Testing of hypothesis: Chi square test and F-test. Analysis of Variance (ANOVA): one way classification, Design of experiments, RBD.

(RBT Levels: L2 & L3) (Ref. Book:1). **10Hrs**

Course Outcomes:

On completion of this course, students are able to:

1. Acquire the idea of significant figures, types of errors during numerical computation.
2. Understand statistical and probabilistic concepts required to test the hypothesis and designing the experiments using RBD.
3. Learn various numerical methods to solve system of linear equations.
4. Understand the roots of algebraic/transcendental equations and solve PDE's numerically.
5. Analyze and solve PDE's related to wave equation arising in vibration analysis.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

1. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers," 7th Ed., cGraw-Hill Edition, 2015

2. Theory of ordinary differential equations, Coddington E., Levinson N., McGraw-Hill publishing Company, TMH Edition, 9th Reprint, 1987..

3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.

Reference books:

1.R.E, Walpole, R.H.Myres, S.L.Myres and Keying Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson, 2012

2.Dr. B.S. Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, 1999.

3.K Shankar Rao, "Introduction to Partial Differential Equations" Prentice - Hall of India Pvt. Lt. , 1995 Edition

4. C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics". 6th edition, McGraw-Hill, 1995.

ADVANCED FOUNDRY TECHNOLOGY			
Course Code	20MSE12	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation.Growth mechanism.Solidification of pure metals andalloys.Mechanism of columnar and dendritic growth.Coring or Segregation.Solidificationtime and Chvorinov's rule. Concept of progressive and directional solidifications.

Principles of Casting and Risering: Purpose of the gating system. Components of the gating system and its functions. Design of the gating System, different types of gates, gating ratioand its functions, definition and functions of the riser.Types of risers and theirapplication.Design of the riser - its shape, size and location.Use of insulating material andexothermic compounds in risers. **10 Hrs**

Module-2

Design of Casting: Factors to be considered in casting design. Design consideration inpattern making, moulding techniques and core making and assembly. Cooling stresses andhot spots in casting and modification in casting geometry to overcome them.

Casting Quality Control: Casting defects and factors responsible for them.Differentinspection and testing methods to evaluate the casting.Quality control activities in afoundry. Salvaging methods of defective casting.

Furnace Technology: Study of variousfurnaces used in foundry, construction and operation of crucible and hearth furnaces.Resistance, Arc and Induction furnaces-their construction, Operation and application. Heattreatment furnaces and drying ovens used in foundry.

10 Hrs

Module-3

Gray Cast - Iron Foundry Practice: Chemical Composition and structure of gray cast iron.Moulding, gating and risering techniques.Melting of gray cast iron in Cupola and inductionFurnace.Inoculation of gray cast iron.Application of gray cast iron castings.

Malleable Cast Iron: Chemical composition and structure of White-heart and black-heartMalleable cast iron. Melting malleabilisation heat treatment and application of malleable castIron.

Ductile Cast Iron: Chemical composition and structure of ductile cast iron. Melting andSpherodisation treatment. Inoculation of ductile iron Properties and application of ductileIron casting. **10 Hrs**

Module-4

Steel Casting Practice: Common steel casting, their composition,structure and properties.Melting and refining of steel. Gating andrisering of steel castings cleaning of steel castings.

Aluminium Foundry Practice: Composition, properties and application of commonaluminium alloy casting. Melting and casting of AI-alloys. Gating and risering of AI-alloycasting.

Copper alloy Foundry Practice: General characteristics of common cast copper alloys.Melting and casting of copper alloys. Gating and risering of cu-alloy castings. **10 Hrs**

Module-5

Foundry Mechanization and Modernization: Introduction to modernization.Mechanization of foundry and its advantages.Mechanization of sand plant, moulding andcore making mechanization in melting, pouring and shakeout units.Material handlingequipment’s and conveyor systems. Brief sketches and

description of layouts of job. Captiveand mechanized foundries.**10 Hrs**
Course outcomes: At the end of the course the student will be able to: 1. Understand the concept of solidification and design of gates and riser in casting. 2. Design casting and apply quality control techniques. 3. Understand and design moulding for grey cast, malleable cast iron and ductile cast iron. 4. Understand and design steel, aluminium and copper alloy casting. 5. Modernize the casting techniques improving the efficient quality.
Question paper pattern: The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60. • The question paper will have ten full questions carrying equal marks. • Each full question is for 20 marks. • There will be two full questions (with a maximum of four sub questions) from each module. • Each full question will have sub question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.
Textbooks
(1) **Foundry Technology –** O.P.Khana
Reference Books
(1) **Principle of metal casting** - Heine, et. al - Tata-McGraw-HiII Publication - 2003.
(2) **A test book of FoundryTechnology**- Lal, M. Khanna, P.O - DhanpatRai& SonsPublication.
(3) **Foundry Technology** - Beelely, P.R. – Butterworth.

ADVANCED ENGINEERING MATERIALS			
Course Code	20MSE13	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Ferrous Materials : Introduction, Fe-C phase diagram, various invariant reactions observed in Fe-C phase diagram, steel, low carbon steel, dual phase steels, micro alloying steels, weathering steels, free cutting steels, medium carbon steels, high strength structure steels, formed steels, martensite stainless steels, Tool materials – classification, properties, heat treatment of high speed steel, Tool for cold and hot forming, tools for high speed cutting, cast iron, Grey cast iron, white cast iron, malleable cast iron, nobular cast iron or ductile iron, vermicular graphite iron, properties and applications.**10 Hrs**

Module-2

Non Ferrous Materials, Super Alloys, Bio-Materials : Introduction, Types of non-Ferrous materials, Cu and Cu alloys, properties and applications, aluminum, cast aluminum alloys, wrought aluminum alloys, properties and Applications, Ti and its alloys, properties and applications Mg and its alloys, properties and applications, super alloys : Ni, Fe and Co based alloys, properties and applications, bio-materials, bio compatibility, applications and properties.**10 Hrs**

Module-3

Polymeric Materials : Introduction to thermoplastic and thermosettting plastics, industrial polymerization method, processing of plastic materials, processes used for thermoplastic materials, injection moulding, extrusion, blow moulding and thermo forming, properties and applications, Processes used thermosettting materials, compression moulding, transfer moulding and injection moduleing, Ceramic materials: processing of ceramics, forming – pressing, dry pressing, isostatic pressing, hot pressing, slip casting , extrusion, thermal treatment, vitrification, properties and applications, Engineering ceramics – alumina, siliconnitrite, silicon carbide, magnetic materials, magnetic fields, Types of magnetism, soft magnetic materials, properties and applications.**10 Hrs**

Module-4

Composite Material, Semi and Super Conducting Materials : Hard magnetic materials, properties and applications, Composite materials : classification, MMC's preparation of composite materials, properties and applications, FRP contains composites preparation of composite materials, properties and applications, particulate RP composite, preparation of composite materials, properties and applications, semi conducting materials, intrinsic and extrinsic semi conduction, semiconductor devices, properties and applications, super conducting materials, current flow and magnetic fields, high critical temperature, super conducting oxide.**10 Hrs**

Module-5

Advanced Materials and Properties of Metal and Alloys: Smart materials: classification, piezo electric materials, Rheological materials, smart gets, chromic materials thermoresponsive materials magnetostrictive materials, electrostrictive materials, nanotechnology materials synthesis, properties, carbon nanotechnology tubes and applications.**10 Hrs**

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1) W F SMITH, Principle of materials science and engineering, Mc Grew Hill, newYork

Reference Books

(1) W D calister, an introduction to material science & engineering, John Wilye

(2) V Raghavan,Material science and engineering, Prentice hall of India (2004)

ADVANCED JOINING PROCESSES			
Course Code	20MSE14	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Distortion- methods to avoid distortion. Stresses in Joint Design. Welding and Cladding of dissimilar materials, overlaying and surfacing. Advanced soldering and Brazing processes different types, Welding of plastics. **10 Hrs**

Module-2

Electro Slag, Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding and Thermit welding. Advanced soldering and Brazing processes, Welding of plastics.**10 Hrs**

Module-3

Inspection of Welds: Destructive techniques like Tensile, Bend, Nick break, Impact & Hardness. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection.
Welding Symbols- Need for, Representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples.**10 Hrs**

Module-4

Welding Design - Introduction, Principles of sound welding design, Welding joint design. Welding positions, Allowable strengths of welds, under steady loads.
Quality Control in Welding - Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts.**10 Hrs**

Module-5

Computer-Aided Welding Design- Introduction. Principles of sound welding design, Wilding joint design. Welding positions. Allowable strengths: of welds. 1D1der steady loads. Weld throat thickness. Solved and unsolved examples.**10 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Introduce the various advanced welding techniques which make them interested to choose a career in the field of welding.
2. Understand the advanced welding practices in Industries and their comparative merits and demerits.
3. Select the right kind of welding techniques for joining raw materials of various thicknesses.
4. Select appropriate welding technique suitable for joining various types of metals.
5. Understand the Computer-Aided Welding Design and Computer- Aided Welding Analysis.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

(1)**Welding Engineering Handbook** - A.W.S.

(2)**Welding Engineering** - Rossi - McGraw Hill.

(3) **Advanced Welding processes** - Nikodaco&Shansky - MIR Publications.

COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION			
Course Code	20MSE15	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Production Development Through CIM: Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, soft and hard prototyping.
Computer Process Monitoring: Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control.**10 Hrs**

Module-2

Computer Aided Quality Control: The computer in Q.C, automated inspection principles and methods, Contact inspection methods, non-contact inspection methods, machine vision system, optical inspection method, sensors, coordinate, measuring machine, Computer-Aided testing, Integration of CAQL with CAD/CAM.
10 Hrs

Module-3

Computer Integrated Manufacturing: Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factor.
Detroit type of Automation: Flow lines, Transfer Mechanisms, work pattern transfer, Different methods & Problems.**10 Hrs**

Module-4

Analysis of Automated flow lines: Analysis of transfer lines without storage with storage buffer single stage, Double stage, Multistage with problems, Automated assembly systems, Design for automated assembly, parts feeding devices, analysis of Multi station assembly machine, Analysis of Single stage assembly machine. **10 Hrs**

Module-5

Automated Material Handling Storage: Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage, interfacing handling & storage with manufacturing.
10 Hrs

Course outcomes:
At the end of the course the student will be able to:

1. Understand the effect of manufacturing automation strategies.
2. Analyze computer aided quality control methods and techniques.
3. Analyse CIM planning system and computer network for manufacturing.
4. Understand and analyse the flow lines and transfer mechanisms.
5. Understand and analyse Automated material Handling Storage system.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

(1) **CAD/CAM** -Zimmers& Grover – PHI.

(2) **CAD/CAM/CIM** - P.Radhakrishna - New Age International - 2nd edition.

(3) **Automation, Production systems & Computer Aided Manufacturing** - M.P. Grover - Prentice Hall - 1984.

LABORATORY - I			
Course Code	20MSEL16	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO	Experiments
1	Determination of Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.
2	Forces measurements during orthogonal turning.
3	Estimation of Power required during orthogonal turning.
4	Torque and Thrust measurement during drilling.
5	Determination of cutting forces during milling using Milling tool dynamometer
6	Measurement of Chip tool Interface temperature during turning using thermocouple technique.
7	Study the variation of surface roughness with different speed and feed during plain milling operation on flat surface.
8	Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
9	To prepare metallic samples for metallographic examination and to study the principle &
10	Study of Microstructure and Hardening of steel in different medium and cooling rates.
11	Effect of Carbon percentage on the hardness of Steel.
12	CNC milling- Writing and execution of part program for contour milling.

Question paper pattern:

The SEE questions will be set for **100** marks:

1. Two experiments for **80** marks.
2. Viva voce for **20** marks.

RESEARCH METHODOLOGY AND IPR			
Course Code	20RMI17	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:0:2	SEE Marks	60
Credits	02	Exam Hours	03

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. **05Hrs**

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **05Hrs**

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. **05Hrs**

Module-4
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. **Chi-square Test:** Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests. **05Hrs**
Module-5
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. **05Hrs**

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.
- Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports
- Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbooks

(1) Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.

(2) Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), RanjitKumar,SAGE Publications,3rd Edition, 2011.

(3) Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books

(1) Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.

(2) Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

*** END OF I SEMESTER ***

THEORY OF METAL CUTTING			
Course Code	20MSE21	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Mechanics of Metal Cutting: Mechanism of chip formation, Orthogonal & Oblique cutting, types of chips, built-up edge, Determination of shear plane angle, forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, Theory of Lee & Shaffer, coefficient of friction, power & energy relationship, velocity relationship, shear-strain, factors affecting forces and power, problems.**10 Hrs**

Module-2

Geometry of Cutting Tools: Single point and multi point cutting tools, tools nomenclature, tool point reference systems, tool angle specifications –ISO and ASA systems, conversion from one system to another. Recommended tool angles, Effect of cutting parameters on tool geometry.

Tool Materials and Their Properties: Characteristics of tool materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, SIALON, CBN, UCON, recommended cutting speeds for the above tools, discussion on steels, air, water, oil hardening of tools and theirapplications.

10 Hrs

Module-3

Measurement of Cutting Forces: Reasons for measuring cutting forces, Classification of cutting force dynamometers – mechanical, hydraulic, pneumatic, optical, inductance, piezoelectric, and strain gage type dynamometers, Dynamometers for lathe, drilling, and milling, Calibration of dynamometers.**10 Hrs**

Module-4

Tool Wear, Tool Life: Mechanisms of tool wear, Sudden & gradual wear, crater wear, flank wear, tool failure criteria, tool life equations, effect of process parameters on tool life, tool life tests, conventional & accelerated tool wear measurement, machinability index.

ThermalAspects in Metal Cutting: Heat sources in metal cutting, temperature in chip formation, temperature distribution, experimental determination of tool temperatures.**10 Hrs**

Module-5

Cutting fluids: Basic actions of cutting fluids, properties of cutting fluids, selection of cutting fluids, application of cutting fluids, filtration of fluids, recommended cutting fluids.

Economics of Machining: Introduction, elements of total production cost, optimum cutting speed and tool life for minimum cost, optimum cutting speed and tool life for maximum production, problems. **10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand and analyze the fundamentals of different cutting tool and materials.
2. Understand and analyze Mechanics of metal cutting.
3. Understand and analyze cutting force and its measurements using dynamometers and temperature distrubution during metal cutting.
4. Understand and analyze tool wear and tool life- mechanisms and effects.
5. Understand and analyze the Thermal Aspects and selection of cutting fluids and Optimum cutting speed and cost. techniques.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

(1) **Metal Cutting Principles** - M.C. Shaw - Oxford Publication – 1985.

(2) **Fundamentals of metal cutting & Machine Tools** - by B.L.Juneja& G.S – Sekhar -Wiley Eastern.

(3)**Metal Cutting** - V.C.Venkatesh&S.Chandrasekhanan - Pantice Hall – 1991.

THEORY OF METAL FORMING			
Course Code	20MSE22	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to Forming process: Introduction to metal forming, Effect of temperature on forming process-hot working, cold working. Effect of Metallurgical structure, Effect of speed of deformation work of Plastic deformation, Friction in forming operation.**10 Hrs**

Module-2

Forging: Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging.

10 Hrs

Module-3

Rolling of Metals: Classification, forces and geometrical relationships in rolling.

Variables in Rolling: Deformation in rolling, Defects in rolled products, Residual stresses in rolled products. Torque and Horsepower. **10 Hrs**

Module-4

Extrusion: Classification, Extrusion equipment, variables in extrusion, Deformation in extrusion, Extrusion defects, Work done in extrusion.

Drawing: Principles of Rod and wire drawing, variables in wire drawing, Residual stresses in rod, wire and tube drawing, Defects in Rod and wire drawing.**10 Hrs**

Module-5

Sheet Metal Forming: Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products.**10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the basics of metal forming.
2. Recognize the importance of metal forging using different geometrical shapes and various defects.
3. Understanding the concept of rolling ,types of rolling mills and processes and its defects
4. To understand the concepts of extrusion and drawing and their applications.
5. To understand the types of sheet metal forming processes and HERF

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

(1) **Mechanical MetalIurgy**- Dieter G.E. - McGraw Hill Publications.
(2)**Principles of Metal Working** - R.Rowe -Amold London – 1965.
(3) **Metals Handbook** – ASM - Volume II -.ASM

ADVANCED PROCESSING OF MATERIALS			
Course Code	20MSE23	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Casting Process: Introduction, various manufacturing processes, convectional casting processes, special casting processes, squeeze casting processes, foam casting, melting processes, Types of furnace, melting using cupola furnace, Resistance furnace, Induction furnace.

Powder Metallurgy Process: Introduction, benefits of power metallurgy process, limitations and applications of process, flow chart of process, various methods of production of powder, powder treatment, powder characteristics, compaction of powder and its methods, pre-sintering, operation before sintering, sintering, operating after sintering.**10 Hrs**

Module-2

Mechanical Alloying: Introduction and process of mechanical alloying, milling parameters in mechanical alloying, material synthesizing using mechanical alloying, phase formed in mechanical alloying, mechanical alloying of miscible systems, mechanical alloying of immiscible systems, oxide dispersion strengthened alloys, reactive milling, phase transition observed in mechanical alloying.

10 Hrs

Module-3

Advance Processing and Forming: Introduction: abrasive finishing, Chemical mechanical polishing (CMP) technology, photochemical machining, high voltage forming of metal, explosive forming or fabrication, Electrochemical hydraulic forming, magnetic pulse forming.**10 Hrs**

Module-4

Processing of polymer materials and latest trends in manufacturing processes: Introduction, processing of plastic, compression moulding, injection molding, extrusionmolding, blow molding, ageing of polymer, Effect of temperature, UV and solar radiations,Introduction to agile manufacturing and green manufacturing, Advantages and application ofagile manufacturing, Advantages and application of green manufacturing.**10 Hrs**

Module-5

Metal injection moulding (MIM) and self-propagating high temperature synthesis processes: Introduction, steps in MIM, Advantages and requirements of MIM, materialsprocesses of MIM, SHS process: Introduction, Types of SHS, reaction mechanics, parametersto be considered in SHS, Types of SHS products and applications microwaves sintering ofmetals process, Types of SHS products and applications, process parameters for microwavesintering, Advantages and limitations.**10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the concept of joining processes for various materials and methods to avoid distortion.
2. Understand various non-conventional welding process.
3. Inspect the welds using DT and NDT techniques and learn the weld symbols.
4. Design the welding and applying quality control techniques.
5. Apply computer software for weld design.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1) MANUFACTURING TECHNOLOGY by ROA P N, TATA Mc Grew Hill 1996

(2) Principles of materials science and engineering by W F SMITH, Tata Mc Grew Hill

Reference Books

(1) Manufacturing engineering and technology by Kalpakjain. S

(2) Modern machining processes by P C Pandey and shah, Tata Mc Grew Hill, NewDelhi.

NON-DESTRUCTIVE TESTING			
Course Code	20MSE241	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction to ND Testing: Selection of ND methods, visual inspection, leak testing, Liquid penetration inspection, its advantages and limitation.**10 Hrs**

Module-2

Magnetic Particle Inspection: Methods of generating magnetic field, types of magnetic particles and suspension liquids steps in inspection – application and limitations.
Eddy Current Inspection: principles, operation variables, procedure, inspection coils, and detectable discounts by the method.**10 Hrs**

Module-3

Ultrasonic inspection: Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A, B, C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks.**10 Hrs**

Module-4

Radiography Inspection: principles, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications.**10 Hrs**

Module-5

Optical Holography: Basics of Holography, recording and reconstruction – Acoustical Holography: systems and techniques applications. Indian standards for NDT.
Microwave Inspection: Microwave holography, applications and limitations.**10 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Distinguish the destructive and non-destructive testing and find effectiveness.
2. Find the surface defect using liquid penetrant and magnetic particle test and eddy current test.
3. Learn the mechanism of flaw detection using ultrasonic wave system.
4. Understand the operations of microwave and radiography inspection system.
5. Understand the basics of holography and interferometry and its application in defect detection.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books
(1) **Non Destructive Testing** - McGonnagle JJ – Garden and reach New York.
(2) **Non Destructive Evolution and Quality Control -** volume 17 of metals hand book 9edition Asia internal 1989.
(3)**The Testing instruction of Engineering materials** - Davis H.E Troxel G.E wiskovilC.T - McGraw hill

RAPID PROTOTYPING			
Course Code	20MSE242	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

INTRODUCTION: History – Development of RP systems – Applications in Product Development, Reverse Engineering, Rapid Tooling, Rapid Manufacturing- Principle – Fundamental – File format – Other translators – medical applications of RP – On demand manufacturing – Direct material deposition – Shape Deposition Manufacturing.**10 Hrs**

Module-2

LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS: Classification – Liquid based system – Stereo lithography Apparatus (SLA),details of SL process, products, Advantages, Limitations, Applications and Uses. Solid basedsystem – Fused Deposition Modeling, principle, process, products, advantages, applicationsand uses – Laminated Object Manufacturing.**10 Hrs**

Module-3

POWDER BASED RAPID PROTOTYPING SYSTEMS: Selective Laser Sintering – principles of SLS process, principle of sinter bonding process, Laser sintering materials, products, advantages, limitations, applications and uses. Three Dimensional Printing – process, major applications, research and development. Direct shell production casting – key strengths, process, applications and uses, case studies, research and development. Laser Sintering System, e-manufacturing using Laser sintering, customized plastic parts, customized metal parts, e-manufacturing – Laser Engineered Net Shaping (LENS).**10 Hrs**

Module-4

MATERIALS FOR RAPID PROTOTYPING SYSTEMS: Nature of material – type of material – polymers, metals, ceramics and composites- liquid based materials, photo polymer development – solid based materials, powder-based materials – case study.**10 Hrs**

Module-5

REVERSE ENGINEERING and NEW TECHNOLOGIES: Introduction, measuring device- contact type and non-contact type, CAD model creation from point clouds-pre-processing, point clouds to surface model creation, medical data processing – types of medical imaging, software for making medical models, medical materials, other applications – Case study.**10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.
2. Explain direct metal laser sintering, LOM and fusion deposition modeling processes.
3. Demonstrate solid ground curing principle and process.
4. Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components.
5. Understand the RP Process Optimizations.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1)Rafiq I. Noorani, Rapid Prototyping, "Principles and Applications", Wiley & Sons, 2006.

(2) Chua C.K, Leong K.F and Lim C.S, "Rapid Prototyping: Principles and Applications",Second Edition, World Scientific, 2003.

Reference Books

(1)N.Hopkinson, R.J.M, Hauge, P M, Dickens, "Rapid Manufacturing – AnIndustrialrevolution for the digital age", Wiley, 2006

(2) Ian Gibson, "Advanced Manufacturing Technology for Medical applications: ReverseEngineering, Software conversion and Rapid Prototying", Wiley, 2006

(3) Paul F.Jacobs, "Rapid Prototyping and Manufacturing: Fundamentals ofStereolithography", McGraw Hill 1993.

FINITE ELEMENT METHODS			
Course Code	20MSE243	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Equations of equilibrium, stress-strain relations for 2-D and 3-D, Potential energy and equilibrium, Boundary conditions, Von Misses Stresses.**10 Hrs**

Module-2

FEM for 1-D Problems: General procedure for FEA, Raleigh Ritz method, Galerkin Approach, shape functions, stiffness matrix, load vectors, temperature effects, Applications of boundary conditions using elimination, penalty and multi-constraint approaches, Application problems – 1-D bar element. Trusses and beams.**10 Hrs**

Module-3

FEM for 2-D Problems: Shape functions, stiffness matrix, strain matrix, load vectors for CST Elements and application problems.
10 Hrs

Module-4

FEM for Axisymmetric Problems: Axisymmetric formulation, triangular elements, PE approach, Body force term, application problems
FEM for Scalar Field Problems: 1-D Steady state heat transfer, torsion, potential flow and fluid flow in ducts and application problems.**10 Hrs**

Module-5

Dynamic Analysis: Equations of motion for dynamic problems -- consistent and lumped mass matrices - formulation of element mass matrices free vibration and forced vibration problems formulation.
. 10 Hrs

Course outcomes:
At the end of the course the student will be able to:
1. Solve differential equations using weighted residual methods
2. Develop the finite element equations to model engineering problems governed by second order differential equations
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books
(1) **Introduction to Finite Elements in Engineering** -Tirupathi R. Chandrupatla,Ashok D Belegundu - Prentice Hall India Pvt. Ltd., New Delhi – Third Edition, 2003.
(2) **Concepts and Applications of finite Element Analysis** - Cook R.D, Malkus D.S&Plesha M.E - John Wiley & Sons - 1989.
(3)**Applied Finite Element Analysis** - Segerlind L .J - John Wiley & Sons Edition -1984.

SIMULATION AND MODELING OF MANUFACTURING SYSTEMS			
Course Code	20MSE244	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Principle of Computer Modelling And Simulation: Monte Carlo simulation. Nature of computer- modeling and simulation.Limitations of simulation, areas of applications.
System and Environment: Components of a system -discrete and continuous systems, Models of a system -a variety of modeling approaches.**10 Hrs**

Module-2

Discrete Event Simulation: Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, too server queue , simulation of inventory problem.
Statistical Models in Simulation: Discrete distributions, continuous distributions.
10 Hrs

Module-3

Random Number Generation: Techniques for generating random numbers- Mid square method -the mod product method -Constant multiplier technique -Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smimov test -the Chi-square test, IvicaCmkovic, Ulfaskluna and AnnitaborsenDohlgvist Publisher Artechhouse**10 Hrs**

Module-4

Random Variable Generation: Inversion transforms technique-exponential distribution. uniform distribution, weibull distribution, continuous distribution, generating approximate normal variates-Erlang distribution.
Empirical Discrete Distribution: Discrete uniform -distribution poisson distribution - geometric distribution -acceptance -rejection technique for Poisson distribution gamma distribution.**10 Hrs**

Module-5

Design and Evaluation Of Simulation Experiments: variance reduction techniques - antithetic variables, variables-verification and validation of simulation models.
Simulation Software: Selection of simulation software, simulation packages.**10 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Describe the role of important elements of discrete event simulation and modeling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
3. Develop skills to apply simulation software to construct and execute goal-driven system models.
4. Interpret the model and apply the results to resolve critical issues in a real world environment.
5.Understand the Input modeling, verification and validation of simulation models.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1) **Discrete Event System Simulation** - Jerry Banks & .John S Carson II - Prentice HallInc.-1984.

(2) **Systems Simulation** - Gordan. G. - Prentice Hall India Ltd - 1991.

Reference Books

(1) **System Simulation with Digital Computer** - NusingDeo - Prentice Hall of India -1979.

(2) **Computer Simulation and Modeling** - Francis Neelamkovil - John Wilely& Sons -1987.

(3)**Simulation Modeling with Pascal** - RathM.Davis& Robert M O Keefe – PrenticeHall Inc. - 1989.

MICRO MACHINING PROCESSES			
Course Code	20MSE251	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

INTRODUCTION: Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport – feedback systems.**10 Hrs**

Module-2

MICROMECHANICS: Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials.
10 Hrs

Module-3

BASIC MICRO – FABRICATION: Bulk Processes – Surface Processes – Sacrificial Processes and Bonding Processes – Special machining: Laser beam micro machining – Electrical Discharge Machining – Ultrasonic Machining – Electro chemical Machining, Electron beam machining.**10 Hrs**

Module-4

MECHANICAL MICROMACHINING: Theory of micromachining – Chip formation – Size effect in micromachining – micro turning, micro milling, micro drilling – Micromachining tool design – Precision Grinding – Partial ductile mode grinding – Ultraprecision grinding – Binder less wheel – Free form optics.**10 Hrs**

Module-5

SEMICONDUCTORS MANUFACTURING: Basic requirements – clean room – yield model – Wafer IC manufacturing – feature micro fabrication technologies – PSM – IC industry – New Materials – Bonding and layer transfer – devices – micro fabrication industries.
10 Hrs

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1) Sami Franssila, "Introduction to Micro Fabrication", John Wiley and sons Ltd., UK,2004, ISBN: 978-0-470-85106-7.

Reference Books

(1)Madore J, "Fundamental of Micro Fabrication", CRC Press, 2002

(2) Mark J. Jackson, “Microfabrication and Nanomanufacturing”, CRC Press, 2006

(3) Peter Van Zant, “Microchip fabrication”, McGraw Hill, 2004

NON-TRADITIONAL MACHINING PROCESSES			
Course Code	20MSE252	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: Need for non-traditional machining processes. Processes selection classification on – comparative study of different processes. **Mechanical Process**: Ultrasonic Machining-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications.
Abrasive Jet Machining: Principles - parameters of the process applications-advantages and disadvantages.**10 Hrs**

Module-2

Thermal Metal Removal Process: Electric discharge machining Principle of operation –mechanism of metal removal basic EDM circuitry-spark erosion get Analysis of relaxation type of circuit material removal rate in relaxation circuits- critical resistance parameters in RO Circuit-Die electric fluids-Electrodes for spark, surface finish, Applications.
Plasma arc Machining: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters-process characteristics - type of torches applications.**10 Hrs**

Module-3

Electro Chemical and Chemical Processes: Electro chemical machining (ECM), Classification ECM process-principle of ECM Chemistry of the ECM parameters of the processes-determination of the metal removal rate - dynamics of ECM process- Hydrodynamics of ECM process-polarization-.Tool Design-advantages and disadvantages - applications. Electro Chemical Grinding-Electro Chemical holding, Electrochemical deburring.
Chemical Machining: Introduction-fundamental principle types of chemical machining Maskants- Etchants- Advantages and disadvantages-application.**10 Hrs**

Module-4

Electron Beam Machining (EBM): Introduction-Equipment for production of Electron beam - Theory of electron beam machining Thermal & Non thermal type characteristics - applications.
Laser Beam Machining (LBM): Introduction-principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations-applications
Ion Beam Machining: Introduction-Mechanism of metal removal and associated equipment process characteristics applications.**10 Hrs**

Module-5

High Velocity Forming Process: introduction - development of specific process selection comparison of conventional and high velocity forming methods - Types of high velocity forming methods-explosion forming process-elector hydraulics forming magnetic pulse forming.**10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Compare conventional and non-conventional manufacturing process and understand the mechanism of USM and AJM.
2. Understand EDM concept and operating characteristic.
3. Distinguish ECM with other operations and various application and understand the usage of various chemical and maskants in CHM.
4. Understand the generation of plasma, electron beam, laser and their machining characteristics.
5. Understand the formation of ion beam and this application and various high velocity forming process.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books

(1) **New technology Institution of Engineers** - Bhattacharya - India

(2) **Production Technology** - HMT - Tata McGraw Hill - ISBN-10; 0070964432

(3) **Modern Machining Process** - P.C Pandy& H.S. Shan - Tata McGraw Hill - **ISBN:**0070965536 - Publishing Date: Feb-80

SURFACE TREATMENT & FINISHING			
Course Code	20MSE253	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Fundamentals of Electro plating, galvanizing, Hot dip metal coating, thin coating, thin coating, chromium plating, Nickel plating.**10 Hrs**

Module-2

Vacuum coating, FVD & CVD metal spraying – Methods, surface preparation, mechanical properties of sprayed metals, plasma coating. **10 Hrs**

Module-3

Plastic coating of metal - PVC coating, Spherodising process details, phosphate coating - mechanism of formation, Testing of surface coating-methods.**10 Hrs**

Module-4

Heat treatment methods, Annealing, Normalizing, Tempering, Case hardening methods, flame hardening sub zero treatment, Heat treatment methods for gears, spindles, cutting tools.**10 Hrs**

Module-5

Advanced coating technologies: Hard facing, electro deposition technique, nano-coatings, coating characterization. **10 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. To understand the principles of operations, tests to evaluate mechanical and tribological properties.
2. To understand the principles of failure analysis and examination of failed components.
3. To understand the strain rate testing, test machine requirements and specimens measurements.
4. To understand and describe the different types of coating and working principles.
5. To learn and understand different heat treatment processes and their effect on finishing.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

1. Surface preparations & finishes for Metals - James A Murphy - McGraw Hill.
2. Principles of metal surface treatment and protection - Pergamon Press Gabe, David Russell - Description, Oxford ; New York - 2d ed., 1978.

INDUSTRIAL DESIGN & ERGONOMICS			
Course Code	20MSE254	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modem manufacturing systems.
Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship-workstation design-working position. **10 Hrs**

Module-2

Control and Displays: shapes and sizes of various controls and displays-multiple displays and control situations - design of major controls in automobiles, machine tools etc., - design of furniture design of instruments.**10 Hrs**

Module-3

Ergonomics and Production: Ergonomics and product design ergonomics in automated systems-expert systems for ergonomic design, Anthropomorphic data and its applications in ergonomic design limitations of anthropomorphic data - use of computerized database.
Visual Effects of Line and Form: The mechanics of seeing psychology of seeing, general influences of lined and form.**10 Hrs**

Module-4

Colour: Colour and light - colour and objects - colour and the eye colour consistency – colour terms - reactions to colour and colour continuation - colour on engineering equipments.
Aesthetic Concepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods.**10 Hrs**

Module-5

Industrial Design in Practice: General design - specifying design equipments - rating the importance of industrial design – industrial design in the design process.**10 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Understanding the concepts of Industrial design and man-machine relationship.
2. Design of optimistic display and control devices for various applications.
3. Applying the anthropomorphic data in ergonomic design.
4. Understanding the visual effects of lines, form and color on engineering equipments.
5. Choosing appropriate aesthetic aspects for design of industrial machinery and devices.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

(1) **Industrial design for Engineers** - Mayall W.H. - LondonCliffee Books Ltd. -1988.

(2) **Applied Ergonomics Hand Book** - Brien Shakel (Edited) - Butterworth Scientific,London – 1988.

LABORATORY - II			
Course Code	20MSEL26	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	0:4:0	SEE Marks	60
Credits	02	Exam Hours	03

Sl. NO	Experiments
1	Study of pick and place Robot- basic components, configuration, work volume.
2	Experiments with Robot. Kit for minimum four assembly activities and programming.
3	Programming of robots by manual, lead through and off line methods.
4	Programming languages for stacking of objects in increasing or decreasing size.Palletizingoperations, assembly and inspection operation etc.
5	To become acquainted with the operation of a revolute-type 6 DOF robot. To program a robotic system using a teaching pendant and a high level programming language. Emphasis is made on the constraints associated when positioning and orienting an object within a 3-D space The practical includes point-to-point tasks and continuous robot motion.

Question paper pattern:

The SEE questions will be set for **100** marks:

1. Two experiments for **80** marks.
2. Viva voce for **20** marks.

TECHNICAL SEMINAR			
Course Code	20MSE27	CIE Marks	100
Number of contact Hours/week	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a Faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course 20MSE27 seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

*** END OF II SEMESTER***

NANO TECHNOLOGY			
Course Code	20MSE31	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Module-1

Metal based nanocomposites- Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties.**10 Hrs**

Module-2

Design of Super hard materials- Super hard nano composites, its designing and improvements of mechanical properties.
Nanofiller synthesis - applications, Polymer nano composites, particulate and fibre modified nano composites, matrices and fibres, polymer- filler interphase, pull- out strength, effect of various treatments.**10 Hrs**

Module-3

Mechanics of polymer nanocomposites, Interfacial adhesion and characterisation, factors influencing the performance of nanocomposites, physical and functional properties. Nano composite fabrication, matrices, methods, additives, moulding processes. **10 Hrs**

Module-4

Polymer-carbon nanotubes based composites - processing methods and characterization using OM, SEM, XRD, TEM. **10 Hrs**

Module-5

Characterization of Polymer nanotubes based composites for Mechanical, Electrical and Thermal Properties and their applications - Polymer / nanofillers (metallic nanopowders) systems, Rheological measurements, processing characteristics. Testing of nanocomposites, Thermal analysis such as TGA, TMA, DSC, DMTA . **10 Hrs**

Course outcomes:
At the end of the course the student will be able to:

1. Explain the fundamental principles of nanotechnology and their application to biomedical engineering.
2. Apply engineering and physics concepts to the nano-scale and non-continuum domain.
3. Identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature.
4. Design processing conditions to engineer functional nano materials.
5. Evaluate current constraints, such as regulatory, ethical, political, social and economical, encountered when solving problems in living systems

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) **Polymer Science** - Fred W. Billimeyer, Jr - Wiley Interscience Publication – thirdedition , 1994

Reference Books

(1) **Polymer Science and Technology** - Joel R. Fried - Prentice- Hall, Inc. EnglewoodCliffs, N. J., USA - 2000.

(2) **New Developments and Technology** -Hand book of Elastomers - (Eds. A. K.Bhowmic and H. C. Stephense), Marcel - Dekker Inc., New York - 1995.

(3) **Polymer Blends** - D. R. Paul and S. Newman - Academic Press, New York - 1978.

INDUSTRIAL ROBOTICS			
Course Code	20MSE321	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

FUNDAMENTAL CONCEPTS OF ROBOTICS: History, present status and future trends, Robotics. Robot – Definition, Robotics Systems and Robot Anatomy, Specification of Robotics. Resolution, Repeatability and Accuracy of a Manipulator.

ROBOT DRIVES: Power transmission systems and control Robot drive mechanisms, hydraulic electricpenumatic drives. Mechanical transmission method – Rotary-to-Rotary motion conversion. Rotary-to-linear motion conversion end effectors – types-grip pind problem Remote-Centered compliance Devices-Control of Actuators in Robotic Mechanisms.**08 Hrs**

Module-2

SENSORS AND INTELLIGENT ROBOTS: Sensory devices – Non-optical-Position sensors – Optical position sensors – velocity sensors – proximity sensors: Contact and noncontact type-Touch and slip sensors – Force and Torque Sensors – AI and Robotics **08 Hrs**

Module-3

COMPUTER VISION FOR ROBOTICS SYSTEMS: Robot vision systems – Imaging components – Image representation – Hardware aspects-Picture coding – Object Recognition and Categorization-Visual inspection – software considerations – applications – commercial– Robotics vision systems.

COMPUTER CONSIDERATIONS FOR ROBOTIC SYSTEMS: Computer architecture for robts, hardware, Computational elements in robotic applications – Robot programming – sample programs path planning – Robot's computer system. **08 Hrs**

Module-4

TRANSFORMATIONS AND KINEMATICS: Homogeneous Co-ordinates – Co-ordinate Reference Frames – Homogeneous Transformations for the manipulator – the forward and inverse probleme of manipulator kinematics – Motion generation – Manipulator dynamics – Jacobian in terms of D.H.Matrices controller architecture. **08 Hrs**

Module-5

ROBOT CELL DESIGN AND CONTROL: Specifications of Commerical Robots – Robot Design and Process specifications – motor selection in the design of a robotic joint – Robot Cell layouts – Economic and Social aspects of robotics.

APPLICATIONS OF ROBOTS: Capabilities of Robots – Robotics Applications – Obstacle avoidance – Robotics in India – The future of Robotics. **08 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the concept of robotics and its drives.

2. Understand the sensors applications and images recognition mechanism.

3. Program robot and analyse the computational element of robot computer system.

4. Transform robot manipulator using knowledge kinematics and mathematical methods.

5. Design and control robot cells and understand the application of robots.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) **Robotics Engineering An integrated approach** - Richard D Klafter, Thomas AChmielewski, Michael Negin – Prentice Hall of India Pvt. Ltd. - Eastern Economy Edition, 1989.

(2) **Robotics: Control Sensing, Vision, intelligence** - Fu KS Gomaler R C, Lee C S G -McGraw Hill Book Co. - 1987.

Reference Books

(1) **Handbook of Industrial Robotics** - Shuman Y. Nof - John Wiley & Sons, New York- 1985.

(2) **Robotics Technology and Flexible Automation** - Deb SR - McGraw Hill BookCo. -1994

TOOL DESIGN			
Course Code	20MSE322	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Tool-design Methods: Introduction, the design procedure, drafting and design techniques in tooling drawing

Tool-making Practices: Introduction, tools of the tool maker, hand finishing and polishing, screws and dowels, hole location, jig-boring practice, installation of drilling bushings, punch and die bushings, punch and die manufacture, EDM, EDM for cavity applications, tracer and duplicating mills for cavity applications, low-melting tool materials. **08 Hrs**

Module-2

Tooling Materials and Heat Treatment: Introduction, properties of materials, ferrous tooling materials, non-ferrous tooling materials, non-metallic tooling materials, heat treatment and tool design.

Design of Cutting Tools: Introduction, the metal cutting process, revision of metal cutting tools-single point cutting tools, milling cutters, drills and drilling, reamers, taps. Selection of carbide tools, determining the insert thickness for carbide tools.

08 Hrs

Module-3

Design of Tools for Inspection and Gauging: Introduction, work piece quality criteria, principles of gauging, types of gages and their applications, amplification and magnification of error, gage tolerances, selection of material for gages, indicating gages, automatic gages, gauging positionally tolerance parts, problems.

Locating and Clamping Methods: Introduction, basic principle of location, locating methods and devices, basic principle of clamping.

08 Hrs

Module-4

Design of Drill Jigs: Introduction, types of drill jigs, general considerations in the design of drill jigs, drill bushings, methods of construction, drill jigs and modem manufacturing.

Designof Fixtures: Introduction, types of fixtures, fixtures and economics.

Design of Press-working Tools: Power presses, cutting operations, types of die-cutting operations - and their design, evolution of blanking and progressive blanking. **08 Hrs**

Module-5

Design of Sheet Metal Bending, Forming and Drawing Dies: Introduction, bending dies, forming dies, drawing dies. Evolution of a draw die, progressive dies and selection of progressive dies. Strip development for progressive dies, evolution of progressive dies, examples of progressive dies. Extrusion dies, drop forging dies and auxiliary tools, problems.

Tool Design for Joining Processes: Introduction, tooling for physical joining processes, tooling for soldering and brazing, tooling for mechanical joining processes, problems. **08 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Understand the tool design concept and design the single point cutting tool.
2. Design the mill cutters, broach and clamping devices.
3. Understand the application of jigs and fixtures, gauges and design them.
4. Understand the concept of press tools and its dies.
5. Design forming dies and understand the classification and application of automats.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) **Tool Design** - Cyril Donaldson, GH Lecain and VC Goold - TMH Publishing Co Ltd., New Delhi, - 3rd editions, 2000.

(2) **Fundamentals of Tool Design** – ASTME - PHI (P) Ltd., New Delhi -1983.

Reference Books

(1) **Cutting Tool Design** - Rodin - Mir publications -1968.

(2) **Metal cutting & Tool Design** - Arshinov -Mir Publishers , Moscow – 1970.

(3) **Press working of metals** – Hinman -McGraw Hill – 1950.

SMART MATERIALS			
Course Code	20MSE323	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect- Application, Processing and characteristics.
Shape Memory Alloys: Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators. **08 Hrs**

Module-2

Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others). Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements.
08 Hrs

Module-3

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations. Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Mollusks.
Biomimetic sensing, Challenges and opportunities. **08 Hrs**

Module-4

MEMS: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Microfabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design. Piezoelectric Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies, Comparison of major sensing and actuation methods. **08 Hrs**

Module-5

Polymer MEMS& Micro fluidics: Introduction, Polymers in MEMS (Polyimide, SU8,LCP,PDMS, PMMA, Parylene,Others) Applications(Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves.
Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development:Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties. **08 Hrs**
Investment and competition.

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) "Smart Structures –Analysis and Design", A.V.Srinivasan, Cambridge University Press,New York, 2001, (ISBN:0521650267).

(2) "Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall,London, 1992 (ISBN:0412370107)

Reference Books

(1) Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects ofShapememory Alloys", Butterworth – Heinemann, 1990.

(2) Rogers, C. A., Smart Materials, "Structures and Mathematical issues", TechnomicPublishing Co., U.S.A, 1989.

(3) Mel Schwartz (Ed), Encyclopaedia of Smart Materials" Volume –I and II, John Wiley &Sons, Inc.2002

PRECISION ENGINEERING			
Course Code	20MSE324	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

CONCEPTS OF ACCURACY AND MACHINE TOOLS: Part Accuracy – errors, accuracy of machine tools – spindle accuracy – displacement accuracy – errors due to numerical interpolation – definition of accuracy of N.C system – errors in the NC machines – feed stiffness – zero stability. **08 Hrs**

Module-2

STIFFNESS, THERMAL EFFECTS AND FINISH MACHINING: Overall stiffness of Lathe – compliance of work piece – errors caused by cutting forces – deformation in turning – boring – milling – heat sources – thermal effects – Finish Turning, boring, grinding – Surface roughness. **08 Hrs**

Module-3

DIMENSIONING: Definition of terms – Key dimension – Superfluous dimension – dimensional stepped shaft – assigning tolerances in the constituent dimensions – dimensional chains. **08 Hrs**

Module-4

MICRO-MACHINING MICRO-FABRICATION: Micro Machining – Photo resist process – Lithography – LIGA Process – Optical, processing of materials – electron beam machining – beam machining – micro forming, diamond turning – micro positioning devices – etching – physical vapour deposition – Chemical vapour deposition. **08 Hrs**

Module-5

SMART STRUCTURES, MATERIALS AND MICRO ACTUATORS: Smart structures – Smart materials types and applications – smart sensors – micro valves –MEMS – Micro motors – Micro pumps – micro dynamometer – micro machines – microoptics – micro nozzles. **08 Hrs**

Course outcomes:
At the end of the course the student will be able to:

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) Murthy R.L., "Precision Engineering in Manufacturing", New Age International Pvt, 2005.

(2)JuliarW.Gardner. Vijay K. Varadan, “Micro sensors, MEMS and Smart Devices”, John Wiley and sons, 2001.
Reference Books
(1) Stephen A.Campbell,“The Science and Engineering of Microelectronic Fabrication”, Oxford University Press, 1996.
(2)Raady Frank, “Understanding Smart Sensors”, Artech. House, Boston, 1996.
(3) MEMS Hand Book, CRC Press, 2001.

COMPOSITE MATERIALS			
Course Code	20MSE331	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction to Composite Materials: Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction. **08 Hrs**

Module-2

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli – Rule of mixture, Macro mechanics of a lamina: Hooke's law for different types of materials, number of elastic constants, Laminate code, Failure criterion. **08 Hrs**

Module-3

Manufacturing: Lay Up and Curing – open and closed mould processing – Hand lay up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance Introduction, material qualification, types of defects, NDT methods. **08 Hrs**

Module-4

Fabrication of Composites: Cutting, machining, drilling, mechanical fasteners & adhesive bonding joining computer aided design manufacturing tooling fabrication equipment

Design of Fibre Reinforced Composite Structures: Introduction, Composite structural design, Design criteria, Laminate design, Mathematical analysis of the laminate, Design of composite stiffeners. **08 Hrs**

Module-5

Application Developments – Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

Metal Matrix Composites: Re-inforcement materials, types, Characteristics & Selection, base metals-selection, applications.
Powder metallurgy technique, liquid metallurgy technique. **08 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.
2. Identify, describe rule of mixture and failure criteria for composites.
3. Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of composite materials.
4. Understand and analyse fabrication of composites and design of structure of composites.
5. Understand and recommend composites for different applications and MMCs

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) **Composite Materials Handbook** - Mein Schwartz - McGraw Hill Book Company - 1984.

(2) **Mechanics of Composite Materials** - AutarK.Kaw - CRC Press New York - 1st edi, 1997.

AGILE MANUFACTURING			
Course Code	20MSE332	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Introduction -What is agile Manufacturing? - Competitive environment of the future the business case for agile manufacturing conceptual frame work for agile manufacturing. **08 Hrs**

Module-2

Four Core Concepts: Strategy driven approach - integrating organization, people technology interdisciplinary design methodology. **08 Hrs**

Module-3

Agile Manufacturing and Change Management: The change implications. Post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal, product costing - performance, measurement and control systems, Traditional organization, control technological and design paradigms traditional problems in workplace- organizational issues - role of technology. **08 Hrs**

Module-4

Agile Manufacturing Enterprise Design: Agile manufacturing - enterprise design, system concepts as the basic manufacturing theory - joint technical & organizational design and a model for the design of agile manufacturing enterprise, enterprise design process insights into design processes, what is interdisciplinary design, Main issues - simple design example. **08 Hrs**

Module-5

Skill & Knowledge Enhancing Technologies for Agile Manufacturing: Skill and Knowledge enhancing Technologies - scheduling - technology design strategic-Design Concepts. Design and Skill of Knowledge enhancing Technologies for machine tool systems - Historical overview, Lessons, problems and Future development. **08 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the agile manufacturing and conceptual frame work.
2. Analyse the four core concept of agile manufacturing.
3. Study the implication of advanced manufacturing system.
4. Understand and design the agile manufacturing enterprises.
5. Design skill and knowledge enhancing technology for agile manufacturing.

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

(1) **Agile manufacturing - Forging new Frontiers** - Paul T. Kidd - Addison WesleyPublication -1994.
(2) **Agile Manufacturing – Proceedings of International Conference** - Dr. M.PChowdiah (Editor) – TataMcGraw Hill Publications - 1996.
(3) **On agile manufacturing** - Tata McGraw Hill Publications -1996

OPERATIONS MANAGEMENT			
Course Code	20MSE333	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Operations Planning Concepts: Introduction, Operations Functions in Organizations, Historical development, Framework for managing operations, The trend: Information and Non-manufacturing systems, Operations management, Factors affecting productivity, International dimensions of productivity, The environment of operations, Production systems decisions- a look ahead. **08 Hrs**

Module-2

Operations Decision Making : Introduction, Management as a science, Characteristics of decisions, Framework for decision making, Decision methodology, Decision Tree Problems, Economic models-Break Analysis in operations, P/V ratio, Statistical models.

System Design and Capacity: Introduction, Manufacturing and service systems, Design and systems capacity, Capacity planning.

08 Hrs

Module-3

Forecasting Demand: Forecasting objectives and uses, forecasting variables, Opinion and Judgmental methods, Time series methods, Moving Average methods, Exponential smoothing, Trend adjusted Exponential Smoothing, Regression and correlation methods, Application and control of forecasts-Mean Absolute Deviation, BIAS, Tracking Signal.

Aggregate Planning and Master Scheduling: Introduction- planning and scheduling, Objectives of aggregate planning, Three Pure Strategies, Aggregate planning methods, Master scheduling objectives, Master scheduling methods. **08 Hrs**

Module-4

Material and Capacity Requirements Planning: Overview: MRP and CRP, MRP: Underlying concepts, System parameters, MRP logic, System refinements, Capacity management, CRP activities.

Scheduling and Controlling Production Activities: Introduction, PAC, Objectives and Data requirements, Loading –Finite and Infinite Scheduling methodology, priority sequencing, capacity control.

08 Hrs

Module-5

Single Machine Scheduling: Concept, measures of performance, SPT rule, Weighted SPT rule, EDD rule.

Flow –Shop Scheduling: Introduction, Johnson's rule for 'n' jobs on 2 and 3 machines, CDS heuristic.

Job-Shop Scheduling: Types of schedules, Heuristic procedure, scheduling 2 jobs on 'm' machines. **08 Hrs**

Course outcomes:

At the end of the course the student will be able to:

1. Understand the basic concept of OM, manufacturing trends in INDIA.
2. Design of product layout, process layout and analyse process and capacity.
3. Applying appropriate inventory planning technique.
4. Forecast the demand and prepare MPS.
5. Constructing MRP, MRPII and schedule the jobs and machines.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Textbooks

(1) Monks, J.G., Operations Management, McGraw-Hill International Editions, 1987.

(2) Productions & operations management by Adam & Ebert.

Reference Books

(1)Buffa, Modern Production/Operations Management, Wiely Eastern Ltd.

(2)Chary, S.N., Production and Operations Management, Tata-McGraw Hill.

(3) Operations management by James Dilworth.

QUALITY AND RELIABILITY ENGINEERING			
Course Code	20MSE334	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Module-1

Basic Concepts: Definitions of quality and Reliability, Parameters and Characteristics, Quality control, statistical Quality Control, Reliability concepts.
Concepts in Probability and Statistics : Events, Sample Space, Probability rules, Conditional probability, Dependent and Independent Events, Application of Probability concepts in Quality Control, Problems. **08 Hrs**

Module-2

Introduction to Probability Distributions: Normal, Poisson and Binomial distribution.
Control Charts: Variable Chart – X Bar chart, R-chart and Sigma chart. Attribute Chart : P – Chart, nP Chart, C-Chart and U – Chart. **08 Hrs**

Module-3

Acceptance Sampling: Fundamentals of acceptance sampling, types of acceptance sampling, Curve, AQL, LTPD, AOQL.
Failure Data Analysis : Introduction, Failure Data, Quantitative measures, MTTF, MTBF, Bathtub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis. **08 Hrs**

Module-4

System Reliability: Series, parallel and mixed configuration, Block diagram concept, r- out of-n structure solving problems using mathematical models.
Reliability Improvement and Allocation : Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Prediction and Analysis, Problems. **08 Hrs**

Module-5

Maintainability and Availability: Introduction, Formulas, Techniques available to improve maintainability and availability trade-off among reliability, maintainability and availability, Simple problems. **08 Hrs**

Course outcomes:
At the end of the course the student will be able to:
1. Understand the quality and basic probability concept.
2. Construct the control chart for variables.
3. Construct the control chart for attributes and analyse failure data.
4. Construct OC curve for determining the probability of lot acceptance.
5. Understand the basic concept of reliability and calculate maintainability and availability ofresources.

Question paper pattern:
The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module. ■

Reference Books

(1) **Quality Planning and Analysis -** Tata McGraw - Juran, J.M and Gryna, F.M. – Hillpublishing Coimpany Ltd., New Delhi, India – 1982.

(2) **Maintainability and ReliabilityHandbook of Reliability Engineering andManagement -** Editors – Ireson. W.G. and Cooms-C.F. McGraw - Hill BookCompany Inc. – 1988.

(3) **Concepts in Reliability Engineering-**Srinath L S - Affiliated East-West PressPrivate Limited, New Delhi, India. – 1985.

PROJECT WORK PHASE – 1			
Course Code	20MSE34	CIE Marks	100
Number of contact Hours/Week	2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification, formulation, and solution.
- Design engineering solutions to complex problems utilising a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

MINI PROJECT			
Course Code	20MSE35	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	02	Exam Hours/Batch	03

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Mini-Project: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be able to:

- Present the mini-project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

CIE procedure for Mini - Project:

The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Semester End Examination

SEE marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session in the ratio 50:25:25 by the examiners appointed by the University.

INTERNSHIP / PROFESSIONAL PRACTICE			
Course Code	20MSEI36	CIE Marks	40
Number of contact Hours/Week	2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

To put theory into practice.

To expand thinking and broaden the knowledge and skills acquired through course work in the field.

To relate to, interact with, and learn from current professionals in the field.

To gain a greater understanding of the duties and responsibilities of a professional.

To understand and adhere to professional standards in the field.

To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

To identify personal strengths and weaknesses.

To develop the initiative and motivation to be a self-starter and work independently.■

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. ■

Course outcomes:

At the end of the course the student will be able to:

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics. ■

Continuous Internal Evaluation CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with
Semester End Examination SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■

PROJECT WORK PHASE -2			
Course Code	20MSE41	CIE Marks	40
Number of contact Hours/Week	4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas. ■

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism. ■

Course outcomes:

At the end of the course the student will be able to:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it. ■

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question and Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University. ■