BRANCH: *Mechanical Engineering*

SEMESTER - 8

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME402	Design of Machine Elements II	3-0-0	3	A
ME404	Industrial Engineering	3-0-0	3	B
	Elective 4	3-0-0	3	C
	Elective 5 (Non Departmental)	3-0-0	3	D
ME492	Project		6	S

Total Credits = 18 **Hours: 30** **Cumulative Credits= 180**

Elective 4:-

1. ME462 Propulsion Engineering
2. ME464 Robotics and Automation
3. ME466 Computational Fluid Dynamics
4. ME468 Nanotechnology
5. ME472 Failure Analysis and Design
6. ME474 Micro and Nano Manufacturing
7. ME476 Material Handling & Facilities Planning

ELECTIVE 5 (NON DEPARTMENTAL ELECTIVE COURSES)

(Note:- If a student has studied or chosen the elective course given within the brackets then the corresponding ND elective cannot be chosen)

1. AO482 FLIGHT AGAIST GRAVITY
2. AE482 INDUSTRIAL INSTRUMENTATION
3. AE484 INSTRUMENTATION SYSTEM DESIGN
4. AU484 MICROPROCESSOR AND EMBEDDED SYSTEMS
5. AU486 NOISE, VIBRATION AND HARSHNESS
6. BM482 BIOMEDICAL INSTRUMENTATION
7. BM484 MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES
8. BT461 DESIGN OF BIOLOGICAL WASTEWATER SYSTEMS
9. BT362 SUSTAINABLE ENERGY PROCESSES
10. CH482 PROCESS UTILITIES AND PIPE LINE DESIGN
11. CH484 FUEL CELL TECHNOLOGY
12. CE482 ENVIRONMENTAL IMPACT ASSESSMENT
13. CE484 APPLIED EARTH SYSTEMS
14. CE486 GEO INFORMATICS FOR INFRASTRUCTURE MANAGEMENT
15. CE488 DISASTER MANAGEMENT
16. CE494 ENVIRONMENT HEALTH AND SAFETY
17. CS482 DATA STRUCTURES
18. CS484 COMPUTER GRAPHICS
19. CS486 OBJECT ORIENTED PROGRAMMING
20. CS488 C # AND .NET PROGRAMMING
21. EE484 CONTROL SYSTEMS (ME 362/ CONTROL SYSTEM ENGINEERING)
22. EE486 SOFT COMPUTING

23. EE488 INDUSTRIAL AUTOMATION (ME464/ ROBOTICS AND AUTOMATION)

24. EE494 INSTRUMENTATION SYSTEMS

25. EC482 BIOMEDICAL ENGINEERING

26. FT482 FOOD PROCESS ENGINEERING

27. FT484 FOOD STORAGE ENGINEERING

28. FT486 FOOD ADDITIVES AND FLAVOURING

29.IE482 FINANCIAL MANAGEMENT

30. IE484 INTRODUCTION TO BUSINESS ANALYTICS

31.IE486 DESIGN AND ANALYSIS OF EXPERIMENTS

32. IE488 TOTAL QUALITY MANAGEMENT

33.IC482 BIOMEDICAL SIGNAL PROCESSING

34. IT482 INFORMATION STORAGE MANAGEMENT

35. MA482 APPLIED LINEAR ALGEBRA

36. MA484 OPERATIONS RESEARCH (ME 372/ OPERATIONS RESEARCH)

37. MA486 ADVANCED NUMERICAL COMPUTATIONS

38. MA488 CRYPTOGRAPHY

39.MP482 PRODUCT DEVELOPMENT AND DESIGN

40. MP469 INDUSTRIAL PSYCHOLOGY & ORGANIZATIONAL BEHAVIOUR

41. MP484 PROJECT MANAGEMENT

42. MT482 INDUSTRIAL SAFETY

43. FS482 RESPONSIBLE ENGINEERING

44. SB482 DREDGERS AND HARBOUR CRAFTS

45. HS482 PROFESSIONAL ETHICS

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME 402	Design of Machine Elements-II	3-0-0-3	2016

Prerequisite: ME401 Design of Machine Elements-I

Course Objectives:

- To provide basic design methods for clutches, brakes, belt drives, bearings, gears and connecting rod.
- To introduce the design modifications to be considered for ease of manufacturing.

Syllabus

Design of single plate clutches, multiple disc clutches, cone clutch, centrifugal clutch, block brake, band brake, band and block brake, internal expanding shoe brake, rolling contact bearing, sliding contact bearing, spur gear, helical gear , bevel gear, worm and worm wheel, design of flat belt, design of V-belt drives, selection of roller chains, connecting road, design recommendations for forgings, castings, welded products, rolled sections, turned parts, screw machined products, parts produced on milling machines.

Expected outcome:

The students will be able to

1. Apply design procedures for industrial requirements.
2. Design machine components to ease the manufacturing limitations.

Text Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Jalaludeen , Machine Dsign, Anuradha Publications, 2016
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2016

References Books:

1. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2011
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
3. Rajendra Karwa, Machine Design , Laxmi Publications (P) LTD, New Delhi, 2006
4. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company, 1983

Data books permitted for reference in the examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. Narayana Iyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill, 1984
3. PSG Design Data, DPV Printers, Coimbatore, 2012

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Clutches – friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch	2	15%
	Brakes- Block brake, band brake, band and block brake, internal expanding shoe brake	3	
II	Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load	4	15%
	Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommerfield number, design considerations, heat balance, bearing housing and mountings	4	
FIRST INTERNAL EXAM			
III	Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (review only), virtual or formative number of teeth, gear tooth failures, Beam strength, Lewis equation, Buckingham's equation for dynamic load, wear load, endurance strength of tooth, surface durability, heat dissipation – lubrication of gears – Merits and demerits of each type of gears.	3	15%
	Design of spur gear	3	
IV	Design of helical gear	2	15%
	Design of bevel gear	2	
	Design of worm & worm wheel	3	
SECOND INTERNAL EXAM			
V	Design of flat belt- materials for belts, slip of the belts, creep, centrifugal tension	3	20%
	Design of V-belt drives, Advantages and limitations of V-belt drive	3	
	Selection of roller chains, power rating of roller chains, galling of roller chains, polygonal action, silent chain.	3	
VI	Connecting rod – material, connecting rod shank, small end, big end, connecting rod bolts, inertia bending stress, piston	5	20%
	Pressure vessels, thin cylinders, Thick cylinder equation, open and closed cylinders.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Note : Use of approved data book is permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 3 questions from module I and II and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B
There should be 3 questions from module III and IV and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C
There should be 3 questions from module V and VI and at least 1 question from each module
Each question carries 20 marks
Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME404	INDUSTRIAL ENGINEERING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart theoretical knowledge about various tools and techniques of Industrial Engineering.
- To create awareness about various safety procedures to be followed in carrying out different types of projects.
- To get acquainted with the Inventory management Principles and Techniques.
- To equip with the theoretical knowledge on Quality control practices and testing methods.

Syllabus

Introduction to Industrial Engineering, Plant layout and Material handling, Methods engineering, Industrial relations, Production planning and control, Quality control and Inspection

Expected outcomes:

The students will be able to

i. Know various tools and techniques in industrial Engineering.
ii. Develop work procedure applying the principles of work study.
iii. Apply inventory control techniques in materials management.
iv. Formulate replacement and purchase decisions and arrive at conclusions

Text Books:

1. B. Kumar, Industrial Engineering Khanna Publishers,2013
2. M Mahajan, Industrial Engineering & Production Management, Dhanpat Rai, 2005
3. Martand Telsang, Industrial Engineering & Production Management, S. Chand, 2006
4. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai, 2010

References:

1. E. S. Buffa, Modern Production management, John Wiley, 1983
2. Grant and Ieven Worth, Statistical Quality Control, McGraw Hill, 2000
3. Introduction to work study – ILO, Oxford And IBH Publishing,2008
4. Ralph M Barnes, Motion and Time Study, Wiley, 1980

Course

Module		Hours	End Sem. Exam Marks
I	Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering - Field of application of Industrial Engineering Product Development and research- Design function - Objectives of design, - Manufacturing vs purchase- Economic aspects- C-V-P analysis – simple problems-Development of designs- prototype, production and testing - Human factors in design- Value Engineering .	7	15%
II	Plant layout and Material handling- principles of material handling, Types of material handling equipments, Selection and application. Preventive and break- down maintenance - Replacement policy-- Methods of replacement analysis-Method of providing for depreciation- Determination of economic life - Simple problems.	7	15%

FIRST INTERNAL EXAM			
III	Methods engineering: Analysis of work methods using different types of process chart and flow diagrams- Critical examination- Micro motion study and therbligs- Principles of motion economy – Work measurement-Performance rating.-Determination of allowances and standard time. - Job evaluation and merit rating - Objectives and principles of job evaluation--Wages and Incentives- Primary wage systems- Wage incentive plans.	7	15%
IV	Industrial relations- Psychological attitudes to work and working conditions - fatigue- Methods of eliminating fatigue- Effect of Communication in Industry-Industrial safety-personal protective devices-, causes and effects of industrial disputes- Collective bargaining- Trade union - Workers participation in management.	7	15%
SECOND INTERNAL EXAM			
V	Production planning and control- Importance of planning - job, batch and mass production-Introduction and need for a new product- product life cycle. - Functions of production control - Routing , Scheduling, dispatching and follow up- Gantt charts. Inventory Control, Inventory models -Determination of EOQ and reorder level- simple problems- Selective inventory control techniques.	7	20%
VI	Quality control and Inspection- Destructive and non-destructive testing methods- process capability- Statistical quality control – causes of variation in quality- control charts for X and R. Reliability- causes of failures- Bath tub curve.-System reliability- life testing- Introduction to concepts of, TQM, ISO, Six Sigma and Quality circles (Brief description only).	7	20%
END SEMESTER EXAM			

Question paper pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI. Each question carries 10 marks. Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P	Credits	Year of Introduction
IE306	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	3-0-0	3	2016

Prerequisite: Nil

Course Objectives

- To develop knowledge on structures, decision phases, measures and tools of supply chains.
- To develop understanding on the strategic, tactical and operational decision tools of supply chains.
- To impart knowledge on logistics management and related advanced tools and techniques.

Syllabus

General features of supply chains, planning demand and supply, forecasting, aggregate planning, network design, locations, layouts etc. Supply chain inventory planning decisions, multi-echelon cycle and safety inventory systems: Logistics management: design of transportation network. Routing, scheduling and sequencing. Advanced logistics decision models.

Expected Outcome

The students will

i. Understand the structures, decision phases, measures and tools of supply chains.
ii. Understand the strategic, tactical and operational decision tools of supply chains.
iii. Understand knowledge on logistics management and related advanced tools and techniques.

Text Books

1. G. Sreenivasan, Quantitative Models in Operations and Supply Chain Management, PHI
2. Sunil Chopra, Peter Meindl, Supply Chain Management – Strategy, Planning and Operation, Pearson Education.

References

1. David Simchi – Levi & Philip Kaminsk, Designing and Managing the Supply Chain, McGraw-Hill Companies Inc.
2. David Taylor and David Brunt, Manufacturing Operations and Supply Chain Management, Vikas Thomson Learning, 2001.
3. Donald J. Bowersox & David J. Closs, Logistical Management, TMH.
4. Jeremy F. Shapiro, Modeling and Supply Chain,. Thomson Learning, 2001.
5. Martin Christopher, Logistics and supply chain management, Financial times management.

COURSE PLAN

Module	Contents	Hours	End-Sem. Exam. Marks
I	**General Features of Supply Chains:** Supply Chains – Structures, Decision Phases, Performance Drivers and Measures, Metrics. Achieving Strategic Fit and its Obstacles.	7	15%

II	**Planning Demand & Supply:** Planning demand and supply in supply chains – Forecasting techniques for supply chains, Seasonal Forecasting Models, Measure of Forecast errors.	**7**	**15%**
FIRST INTERNAL EXAM			
III	**Aggregate Planning:** Aggregate Planning Strategies, Aggregate Planning models - Quantitative Examples. **Network Design, Locations and Layouts:** Network design in Uncertain Environment, Facility Location and Layout decisions.	**7**	**15%**
IV	**Multi-echelon Inventory Systems:** Inventory Planning Decisions –Estimate of Cycle Inventory, Discounting Models, Multi-item Inventory models, Determination of Safety Inventory, Impact of Supply Uncertainty, Multi- echelon Inventory models, Quantitative Examples. Bullwhip effect.	**7**	**15%**
SECOND INTERNAL			
V	**Logistics Management**: 3PL, 4PL, Design Options for Transportation Network. Routing, Scheduling and Sequencing in Transportation, Vehicle Routing Problems. Quantitative Examples.	**7**	**20%**
VI	**Reverse Logistics:** Reverse logistics and Closed Loop Supply Chains. **Advanced Logistics Decision Models:** Bin Packing Problems, Fixed Charge Problems, Knapsack Problems, Multi-stage transportation problems.	**7**	**20%**
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):
Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV):
(Same as for part A marks)

Part C (Modules V and VI):
(Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME463	Automobile Engineering	3-0-0-3	2016

Pre requisites: Nil

Course objectives

- To know the anatomy of automobile in general
- To understand the working of different automotive systems and subsystems
- To update the latest developments in automobiles

Syllabus:- Engine, clutch, transmission, steering, brakes, suspension and aerodynamics

COURSE OUTCOMES:

The students will be able to:

i. Practically identify different automotive systems and subsystems.
ii. Understand the principles of transmission, suspension, steering and braking systems of an automobile
iii. Develop a strong base for understanding future developments in the automobile industry

Text Books

1. Gupta R.B. Auto design , Satya Prakash, New Delhi, 2015
2. Heinz Heisler, Advanced engine technology, Butterworth-Heinemann,1995
3. Heinz Heisler, Advanced vehicle technology, Society of Automotive Engineers Inc, 2002
4. Hillier and Peter Coobes, Fundamentals of motor vehicle technology, Nelson Thornes, 2004
5. Tom Denton, Automobile mechanical and electrical systems, Butterworth-Heinemann, 2011

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Piston: - material for piston, clearances, piston rings, types, need for two compression rings, oil control ring, piston pin.	1	15%
	Piston for IC engine, piston rings, piston pin, connecting rod, crank shaft, crank pin, cam shaft, valves, fly wheel, fluctuation of energy and size of fly wheel, hub and arms, stress in a fly wheel rim, simple problems.	1	
		1	
	Petrol fuel injection systems: - comparison petrol injection and carbureted fuel supply systems- comparison –multiport fuel injection (MPFI) and common rail direct injection (CRDI) systems.	1	
		1	
	Super charging systems: fundamentals, naturally aspirated engines and supercharged engines– Turbo charger, turbo lag.	1	

	Hybrid cars, safety overview -Formula-I engine technology: overview, electrical technology, brakes, transmission technology.	1	
II	Friction clutch:- fundamentals, driven plate inertia, driven plate transmitted torque, driven plate wear –angular driven plate cushioning and torsional damping, clutch friction materials, when clutch is worn out.	1	**15%**
	Pull type diaphragm clutch, multiple diaphragm clutch, multi-plate hydraulically operated automatic transmission clutch, semi centrifugal clutch, fully automatic centrifugal clutch, and integral single plate diaphragm clutch.	1	
		1	
	Need of gear box, resistance to vehicle motion, power to weight ratio, speed operating range-five speed and reverse sliding mesh, constant mesh, and synchromesh gear boxes:- gear synchronization and engagement.	1	
		1	
	Over drives – hydrodynamic fluid couplings: - efficiency and torque capacity – fluid friction coupling- torque converters.	1	
		1	
FIRST INTERNAL EXAMINATION			
III	Steering:-basic principle of a steering system:- swinging beam system – Ackermann –over steer and under steer – slip angle, camber, caster etc.	1	**15%**
		1	
	Swivel axis inclination: centre point steering, camber, king pin inclination, negative offset, caster, toe-in and toe-out	1	
	Steering gear box: - fundamentals screw and nut steering gear mechanism-worm and roller type steering gear box – Re-circulating ball nut and rocker lever, re-circulating ball rack and sector steering gear box– need of power assisted steering.	1	
		1	
		1	
	External direct coupled and rack and pinion and integrated steering power cylinder, power assisted steering lock limitations	1	
IV	Suspension: - suspension geometry, terminology- Macpherson strut friction and spring offset - suspension roll centers:-roll centers, roll axis, roll centre height, short swing and long arm suspension, transverse double wishbone, parallel trailing double arm and vertical pill strut suspension, Macpherson strut suspension, semi-trailing arm rear suspension, telescopic suspension.	1	**15%**
		1	
	High load beam axle leaf spring, sprung body roll stability. Rear axle beam suspension- body roll stability analysis:- body roll couple, body roll stiffness, body over turning couple	1	

	Body weight transfer, body direct weight transfer couple, body roll couple distribution, body roll weight transfer, lateral force distribution.	1	
	Anti roll bars and roll stiffness:- anti roll bar function, operating principle, anti roll bar action caused by the body rolling, single wheel lift -rubber spring bumper:-bump stop function and characteristics, axis inclination.	1	
	Rear suspension: - live rigid axle suspension, non drive rear suspension- swing arm rear wheel drive independent suspension.	1	
	Low pivot split axle coil spring wheel drive independent suspension, trailing and semi trailing arm rear wheel drive independent suspension.	1	**15%**
	Transverse double link arm rear wheel drive independent suspension, De Dion axle rear wheel suspension - Hydrogen suspension, hydro-pneumatic automatic height correction suspension.	1	
SECOND INTERNAL EXAMINATION			
V	Brakes:- mechanical and hydraulic brakes (review only) – properties of friction lining and pad materials, efficiency, stopping distance, theory of internal shoe brake, equations –	1	**20%**
	effect of expanding mechanism of shoes on total braking torque, equations.	1	
	Braking vehicles:- brakes applied on rear, front and all four wheels, equations –calculation of mean lining pressure and	1	
	heat generation during braking operation, equations. – braking of vehicle moving on curved path, simple problems.	1	
	Anti Lock Braking system (ABS):- need and advantages of ABS – hydro-mechanical ABS - hydro-electric ABS - air-electric ABS.	1	
	Brake servos: - operating principle, vacuum servo - direct acting suspended vacuum assisted brake servo unit operation - hydraulic servo assisted brake systems.	1	
	Pneumatic operated disc brakes – air operated brake systems: - air over hydraulic brake system - Three line brake system-– electronic-pneumatic brakes.	1	
V1	Aerodynamic drag: pressure drag, air resistance, opposing motion of a vehicle, equations, after flow wake, drag	1	**20%**
	coefficients, various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices.	1	
	Aerodynamic lift:-lift coefficients, vehicle lift, underbody floor height versus aerodynamic lift and drag, aerofoil lift	1	
	and drag, front end nose shape.	1	
	Car body drag reduction:-profile edge chamfering, bonnet	1	

	slope and wind screen rake, roof and side panel chamfering, rear side panel taper, underbody rear end upward taper, rear end tail extension, underbody roughness.		
	Aerodynamic lift control:- underbody dams, exposed wheel air flow pattern, partial enclosed wheel air flow pattern, rear end spoiler, negative lift aerofoil wings.	1	
	After body drag: - square back drag, fast back drag, hatch back drag, notch back drag.	1	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME474	Micro and Nano Manufacturing	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

1. To give awareness of different techniques used in micro and nano manufacturing
2. To give in-depth idea of the conventional techniques used in micro manufacturing
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches
4. To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano manufacturing
5. To know different techniques used in Micro Joining and the metrology tools in micro and nano manufacturing.

Syllabus

Introduction to Precision engineering- Bulk micromachining – Micro-energy -Carbon Nanotubes - Molecular Logic Gates and Nanolevel Biosensors - Conventional Micro Machining - Non-conventional micro-nano manufacturing and finishing approaches - Micro and Nano Finishing Processes - Micro and Nanofabrication Techniques - Micro Joining - Characterization and metrology tools.

Expected outcome

The students will

1. get an awareness of different techniques used in micro and nano manufacturing.
2. get in-depth idea of the conventional techniques used in micro manufacturing.
3. become aware about non-conventional micro-nano manufacturing and finishing approaches.
4. get awareness on micro and nano finishing processes.
5. understand micro and nanofabrication techniques and other processing routes in micro and nano manufacturing.
6. know about different techniques used in micro joining and the metrology tools in micro and nano manufacturing.

References:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.
4. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Precision engineering, macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications	1	15%

	Introduction to Bulk micromachining, Surface micromachining-steps, Micro instrumentation – applications, Micro Mechatronics, Nanofinishing – finishing operations.	**1**	
	Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals	**1**	
	Introduction to Micro-energy and chemical system (MECS), Space Micro-propulsion, e-Beam Nanolithography – important techniques, Introduction to Nanotechnology	**1**	
	Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors - applications	**1**	
II	Introduction to mechanical micromachining, Micro drilling – process, tools and applications	**1**	**15%**
	Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications	**1**	
	Micro milling and Micro grinding – process, tools and applications	**1**	
	Micro extrusion- process and applications	**1**	
	micro bending with Laser	**1**	
	Nano- Plastic forming and Roller Imprinting	**1**	
	FIRST INTERNAL EXAMINATION		
III	Introduction to Non-conventional micro-nano manufacturing	**1**	**15%**
	Process, principle and applications – Abrasive Jet Micro Machining, WAJMM	**1**	
	Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications	**1**	
	Micro ECM, Micro LBM - Process principle, description and applications	**1**	
	Focused ion beams - Principle and applications	**1**	
IV	Introduction to Micro and Nano Finishing Processes	**1**	**15%**
	Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF) – process principle and applications	**1**	
	Force analysis of MRAFF process,	**1**	
	Magnetorheological Jet finishing processes	**1**	
	Working principle and polishing performance of MR Jet Machine	**1**	
	Elastic Emission Machining (EEM) – machine description, applications	**1**	
	Ion Beam Machining (IBM) – principle, mechanism of material removal, applications	**1**	
	Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications	**1**	
	SECOND INTERNAL EXAMINATION		
V	Introduction to Micro Fabrication: basics, flowchart, basic chip	**1**	**20%**

	making processes		
	Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp)	**1**	
	Manipulative techniques – process principle, applications	**1**	
	Introduction to Carbon nano materials – CN Tubes	**1**	
	CN Tubes – properties and applications	**1**	
	CN Tube Transistors – Description only	**1**	
	Diamond - Properties and applications	**1**	
	CVD Diamond Technology	**1**	
	LIGA Process	**1**	
V1	Laser Micro welding – description and applications, Defects	**1**	**20%**
	Electron Beam Micro-welding – description and applications	**1**	
	Introduction to micro and nano measurement, defining the scale, uncertainty	**1**	
	Scanning Electron Microscopy – description, principle	**1**	
	Scanning White-light Interferometry – Principle and application	**1**	
	Optical Microscopy – description, application	**1**	
	Scanning Probe Microscopy, scanning tunneling microscopy- description, application	**1**	
	Confocal Microscopy - description, application	**1**	
	Introduction to On-Machine Metrology	**1**	
	END SEMESTER EXAMINATION		

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.