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SHIVAJI UNIVERSITY, KOLHAPUR.

Proposed Syllabus

of

(T.E. & B.E. Mechanical and Automation Engineering)

Semester –V to VIII

To be introduced from the academic year 2015-16
(i.e. from June 2015)

(Subject to the modifications by B.O.S. from time to time)

SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE OF T.E. (MECHANICAL AND AUTOMATION ENGINEERING) SEMISTER V and VI

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2015-16

SEMESTER V

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Non Conventional Energy Sources	3	-	-	3	100	--	-	-	100
2	Microprocessors and Applications	3	--	2	5	100	25	25	--	150
3	Machine Design I	3	--	2	5	100	25	--	--	125
4	Database Management Systems	3	--	2	5	100	25	--	--	125
5	Material Science and Metallurgy	3	--	2	5	100	25	---	--	125
6	Instrumentation and Control	3	--	2	5	100	25	--	25	150
7	Programming and Simulation Lab I	--	--	2	2	--	25	--	--	25
		18	**---**	**12**	**30**	**600**	**150**	**25**	**25**	**800**

L: Lecture, TUT: Tutorial P: Practical, TP: Theory Paper, TW:Term Work POE/OE: Practical/ Oral Exam

UNLESS SPECIFIED THE THEORY EXAMINATION DURATION WILL BE OF 03 HOURS.

[Note: - Examination scheme and term work marks strictly as per above structure]

SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE OF T.E. (MECHANICAL AND AUTOMATION ENGINEERING) SEMISTER V and VI

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2015-16

SEMESTER VI

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Principles of Management	3	-	-	3	100	--	-	-	100
2	Heat and Mass Transfer	3	--	2	5	100	25	--	25	150
3	Machine Design II	3	--	2	5	100	25	25	--	150
4	Manufacturing Automation	3	--	2	5	100	25	--	--	125
5	Applied Hydraulics and Pneumatics	3	--	2	5	100	25	---	--	125
6	Finite Element Analysis	3	--	2	5	100	25	--	--	125
7	Programming and Simulation Lab II	--	--	2	2	--	25	--	--	25
		18	**---**	**12**	**30**	**600**	**150**	**25**	**25**	**800**

L: Lecture, TUT: Tutorial P: Practical, TP: Theory Paper, T/W:Term Work POE/OE: Practical/ Oral Exam

@ Industrial training of minimum two (2) weeks should be done after T.E. (II) in summer vacation and it's assessment will be done in B.E. (I) based on report submitted.

UNLESS SPECIFIED, THE THEORY EXAMINATION DURATION WILL BE OF 03 HOURS.

[Note: - Examination scheme and term work marks strictly as per above structure]

SHIVAJI UNIVERSITY, KOLHAPUR

Structure of B. E. (MECHANICAL AND AUTOMATION ENGINEERING)
Semesters VII & VIII

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2016-17

SEMESTER VII

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Industrial Automation and Robotics	3	-	2	5	100	25	25	-	150
2	P.L.C. & SCADA Programming	3	--	2	5	100	25	--	25	150
3	Metal Cutting and Tool Design	3	--	2	5	100	25	--	--	125
4	Elective-I	3	--	2	5	100	25	--	--	125
5	Elective-II	3	--	2	5	100	25	---	--	125
6	Seminar	-	--	2	2	--	25	--	---	25
7	Project	--	--	2	2	--	50	--	--	50
8	Industrial Training @	--	--	--	--	---	50	--	---	50
		15	**---**	**14**	**29**	**500**	**250**	**25**	**25**	**800**

L: Lecture, TUT: Tutorial P: Practical, TP: Theory Paper, T/W:Term Work POE/OE: Practical/ Oral Exam

@ Industrial training of minimum two (2) weeks should be done after T.E. (II) in summer vacation and it's assessment will be done in B.E. (I) based on report submitted. Work load of the assessment can be assigned to the project seminar guide.

UNLESS SPECIFIED THE THEORY EXAMINATION DURATION WILL BE OF 03 HOURS.

Sr. No.	Elective I	Elective II
1	Computational Fluid Dynamics	Nano Technology
2	Design of Jigs, Fixture and Press Tools	Industrial Product Design
3	Refrigeration and Air Conditioning	Total Quality Management
4	Computer Aided Design and Computer Aided Manufacturing	Mechatronics

SHIVAJI UNIVERSITY, KOLHAPUR

B. E. (MECHANICAL AND AUTOMATION ENGINEERING)

Semesters VII & VIII

WITH EFFECTIVE FROM THE ACADEMIC YEAR 2016-17

SEMESTER VIII

Sr. No.	Subject	L	TUT	P	Total	TP	TW	OE	POE	Total
1	Industrial Engineering	3	-	2	5	100	25	--	--	125
2	Mechanical System Design	3	--	2	5	100	25	25	--	150
3	Advanced Control Systems	3	--	2	5	100	25	--	--	125
4	Elective-III	3	--	2	5	100	25	--	--	125
5	Elective-IV	3	--	2	5	100	25	---	--	125
6	Project	--	--	4	4	--	100	--	50	150
		15	**---**	**14**	**29**	**500**	**225**	**25**	**50**	**800**

L: Lecture, TUT: Tutorial P: Practical, TP: Theory Paper, T/W:Term Work POE/OE: Practical/ Oral Exam

UNLESS SPECIFIED THE THEORY EXAMINATION DURATION WILL BE OF 03 HOURS.

Sr. No.	Elective III	Elective IV
1	Reliability Engineering	Entrepreneurship Development
2	Management of Manufacturing Systems	Production Planning and Control
3	Nonconventional Machining Processes	Noise and Vibration
4	Engineering Optimization	Micro-Electro Mechanical Systems (MEMS)

[Note: - Examination scheme and term work marks strictly as per above structure]

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B.E. (Mechanical and Automation) – Part I

1. INDUSTRIAL AUTOMATION AND ROBOTICS

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks
	Oral Exam: 25 Marks

Course Objectives:

1. To introduce the concepts of advanced automation functions
2. To introduce the aspects of assembly automation including transfer lines.
3. To introduce the importance of robots and robotic work cells in industrial automation.
4. To introduce basic components of a robots and robotic work cells.
5. To introduce the importance and procedure of robot programming.
6. To introduce the application of robot programming for simple industrial applications.

Course Outcomes:

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

1. Understand and discuss the concepts of advanced automation functions
2. Understand the process of assembly automation including transfer lines
3. Understand the robotics and its application areas in industrial automation.
4. Understand robot anatomy and basic components in a robotic work cell including actuators and sensor systems.
5. Understand the robot programming concept.

SECTION I

UNIT I **(03)**

Introduction:

Automated manufacturing systems, fixed /programmable/flexible automation, Need of automation, Basic elements of automated systems- power, program and control.

UNIT II **(10)**

A) Advanced automation functions:

Levels of automation; Industrial control systems in-process and discrete manufacturing industries, Continuous and discrete control, Low cost automation, Economic and social aspects of automation.

B) Assembly Automation:

Types and configurations, Parts delivery at workstations- Various vibratory and non-vibratory devices for feeding and orientation, Product design for automated assembly.

UNIT III **(06)**

Transfer Lines:

Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications, Analysis of transfer lines with and without storage buffers.

SECTION II

UNIT IV **(07)**

A) Fundamentals of Industrial Robots:

Specifications and Characteristics, Criteria for selection.

Dynamic properties of robots-stability, control resolution, spatial resolution, accuracy, repeatability, compliance, work cell control, Interlocks

B) Robotic Control Systems:

Robot Motions, Drives, Actuators, Robot controllers, Power transmission systems.

UNIT V **(06)**

Robotic End Effectors and Sensors:

A. Transducers and sensors: sensors in robotics and their classification, vision sensors, touch (tactile) sensors, proximity and range sensors, force and torque sensing.
B. End Effectors-Types, grippers, various process tools as end effectors, Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

UNIT VI **(08)**

A) Robot Programming:

Methods of defining positions in space, Motion interpolation, branching, Robot program as a path in space, Lead through method, Textual robot programming languages-VAL II.

B) Robot Applications:

Material transfer, Machine loading and/or unloading, Processing operations, Assembly and Inspection.

TERM WORK

1. Minimum six assignments on all above units.
2. Two Programming exercise on lead through programming.
3. Two Programming exercises using various commands of VAL II.
4. One Industrial visit for Industrial automation and Robot application

REFERENCE BOOKS

1. "Automation, Production Systems & Computer Integrated Manufacturing", Mikell P. Groover, PHI Learning Pvt. Ltd. New Delhi, 3rd Edition 2012.
2. "Industrial Robotics, Technology, Programming & Applications",Groover M.P., Weiss, M. Nagel, R.N. & Odrey, N.G. Ashish Dutta , Tata McGraw Hill Education Pvt. Ltd. New Delhi, 2nd Edition, 2012.
3. "Robot Technology Fundamentals", Keramas, James G.,Thomson Learning-Delmar, 2nd Edition, 2002.
4. "Introduction to Robotics, Mechanics & Control", J Craig, Pierson Education, 3rd Edition, 2004.
5. "Robotics-Control, Sensing, Vision and Intelligence", Fu, K.S. Gonzalez, R.C. Lee McGraw Hill Intl. Ed., 2nd Edition, 2007.

6. "Robotics Technology and Flexible Automation",S. R. Deb,Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2nd Edition, 2010.
7. "Hand Book of Industrial Automation ", Shell and Hall Dekkar, 2009.

B.E. (Mechanical and Automation) – Part I

2. PLC AND SCADA PROGRAMMING

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks
	POE: 25 Marks

Course Objectives:

1. To explain the need of PLC based automation and Selection Criteria
2. Students should be able to do troubleshooting and monitoring of a running project
3. To explain the PLC memory mapping and addressing.
4. To illustrate Programming Standard IEC 61131-3
5. To demonstrate PLC project creation, troubleshooting and interfacing
6. To explain SCADA architecture (Development-Runtime, Client Server architectures)
7. To illustrate SCADA project formation and various components like Screens, Tags, reports, Alarms.

Course Outcomes:

After the completion of the course, Students will be able to

1. Do basic level commissioning of PLC and SCADA
2. Understand the PLC specification sheet and PLC architecture (Input/Outputs, CPU, Power supply& Communication Ports)
3. Demonstrate and explain PLC and SCADA automation with respect to application.
4. Interface various automation components with each other.

Section I

UNIT I **(04)**

Automation:

Fundamentals of industrial automation, need and role of automation, evolution of automation. Types of processes, comparison, evolution of PLC, definition, functions, advantages.

UNIT II **(06)**

PLC Hardware:

Architecture, DI-DO-AI-AO examples and ratings, I/O module, working of PLC, scan time, Installation of PLC, Rack installation, Grounding and shielding, physical, electrical, maintenance requirements, planning, verifying. Troubleshooting, Fault diagnosis techniques. Choosing PLC for Applications. Types of PLC.

UNIT III **(10)**

PLC Programming:

Development of Relay Logic Ladder Diagram, Introduction to PLC Programming, Programming devices and languages as per IEC 61131-3 like IL, ST, FBD, CFC, SFC, PLC Timers and Counters, Set - Reset and PLC instructions.PLC Interfacing, Interfacing PLC with Programming Device / Process Loops and various devices.

Section II

UNIT IV **(06)**

Concept of SCADA system and its Evolution:

Architecture of SCADA and its Selection Criteria.
Development - Runtime Concepts, Client- Server Concepts, Database Concepts

UNIT V **(04)**

Application development:

Developing a SCADA project, Creation & Sequencing of Pages. Creating different types of Tags. Creating graphics & animation, Trending, Historical data storage & Reporting, Alarm management.
Comparison of different SCADA packages.

UNIT VI **(10)**

Interfacing PLC with HMI / SCADA project

TERM WORK: Minimum eight assignments of the following

1. Development of PLC project and Ladder program for simple on-off applications.
2. Development of Ladder program for Timing and counting applications.
3. Use of advanced instructions for applications in PLC.
4. Development of SFC Program for batch applications.
5. Structure Text Programming for given process.
6. Upload, Download and PC-PLC Communication via various methods
7. Creating and Configuring a Project and tags in SCADA.
8. Configuring Screens and Graphics.
9. Programming of HMI interfacing with PLC.
10. Communicate PLC with SCADA

REFERENCE BOOKS

1. Programmable Logic Controllers: Principles and Applications, John Webb, Reis, Ronald, Prentice Hall of India, 5th Edition, 2007.
2. Introduction to Programmable Logic Controllers, Gary Dunning, Delmar Thomson Learning, 3rd Edition, 2006.
3. Beginner's Guide To PLC Programming, Neal Babcock, Modern Media & Automation, LLC, 2013.
4. Programmable Logic Controllers, Frank Petruzella, Elsevier India, 3rd Edition, 2007.
5. Programmable Logic Controllers: Programming Methods and Applications, Hackworth, Pearson India, 1st Edition, 2008.
6. Concept of SCADA system and its Evolution, Mini S. Thomas, John Douglas

McDonald, CRC Press, 2015.
7. Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems, Gordon Clarke, Deon Reynders, Edwin Wright, Elsevier Publisher, 1st Edition, 2004.
8. Handbook of SCADA-Control Systems Security, Robert Radvanovsky , Jacob Brodsky, 1st Edition, 2013.

B.E. (Mechanical and Automation) – Part I

3. METAL CUTTING AND TOOL DESIGN

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To understand various factors affecting metal cutting.
2. To understand procedures to design different cutting tools.
3. To learn economics of metal cutting.

Course Outcomes:

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

1. Explain effects of various parameters on metal cutting.
2. Solve the problems based on theory of metal cutting.
3. Design cutting tools for turning, drilling, milling operations.
4. Solve problems based on economics of metal cutting.

Section I

UNIT I **(10)**

Introduction to mechanics of metal cutting:

Theory of Metal Cutting, Concept of speed, feed and depth of cut, orthogonal and oblique cutting, types of cutting operations, tool geometry of single point cutting tool, tool geometry of multipoint cutting tools.-drills, milling cutters, reamers. Various methods of tool nomenclature and their inter relationship.

Chip formation, Types of chips, cutting ratio, shear plane and shear angle, various forces acting at single point cutting tool, Theoretical Determination of shear angle and cutting forces: Shear plane theory–Merchant's models, Lee and Shofer's model. Velocity relations. Force measurement by tool dynamometers.

UNIT II **(06)**

Cutting tool materials and their properties:

Advanced cutting tools, Machinability of Metals- Factors affecting, improvement and machinability index, Tool life - Types of wear, relationship with cutting parameters, Taylor's equation, and improvement measures. Heat generation in machining, its effect on cutting force, tool life and surface finish cutting fluids - Types and selection criteria of cutting fluids.

UNIT III **(04)**

Design of Form tools and Drills:

Types (Flat, circular, Dovetail) Correction of form tools with and without rake angles, drilling tool geometry, nomenclature, design features speeds, feeds, sizes, angles, torque and thrust Timers and Counters, Set - Reset and thrust.

Section II

UNIT IV **(06)**

Deign of milling cutters:

Size of cutter, tool angles, number of teeth, power requirement for milling.

UNIT V **(07)**

Press tools:

Dies, punches, types of presses, clearances, types of dies, strip layout, calculation of press capacity, center of pressure, Design consideration for die elements.

UNIT VI **(06)**

Economic aspects of tooling:

Elements of costs, method of costing and cost estimation, depreciation and economics of tooling –Tool selection and tool replacement with respect to small tools.

TERM WORK

Minimum 6 Assignments based on above topics.

REFERENCE BOOKS

1. Production Technology-HMT –Tata McGraw-Hill Publishing Ltd. 2008
2. Metal cutting theory & Tool design, Mr. Arshinov MIR Publication.
3. Fundamentals of Metal Cutting and Machine Tools, By B. L. Juneja, Nitin Seth, New Edge International Ltd., Reprint 2005.
3. Fundamentals of Tool Design, by David Spitler, Jeff Lantrip, John Nee, David A Smith, ASTME Publication. 5th Edition, 2003.
4. Tool designs, Cyril Donaldson, George H. Le Cain, V. C. Goold, Joyjeet Ghose, Tata McGraw-Hill Education, 2012.
5. Production Engineering, P.C. Sharma, S. Chand Publication, 11th Edition 2008.
6. Theory of Metal Cutting, Sen and Bhattacharya, New Central Book Agency; 2nd Revised edition 2009.
7. Production Tooling Equipment, S.A.J.Parsan, Macmillan; 3rd Edition 2000.

B.E. (Mechanical and Automation) – Part I

4. COMPUTATIONAL FLUID DYNAMICS (ELECTIVE-I)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To introduce students to derivations fluid flow governing equations, their classifications and boundary conditions suited for the numerical solution of fluid equations.
2. To develop numerical skills to discretize the governing equations and solve numerical issues such as errors, stability and convergence those arise in the solution of such equations.
3. To introduce students to fundamentals of grid generation techniques.

Course Outcomes:

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

1. Explain the differential equations for flow phenomena and numerical methods for their solution.
2. Analyze different mathematical models and computational methods for fluid flow and heat transfer simulations.
3. Solve computational problems related to fluid flow and heat transfer.
4. Analyze the accuracy of a numerical solution by comparison to known solutions of simple test problems and by mesh refinement studies.
5. Evaluate forces in both internal and external flows.

Section I

UNIT I **(07)**

Fundamentals of fluid flow modeling:

Review of the equations governing, fluid flow and heat transfer, finite difference equations, consistency explicit and implicit methods, error and stability analysis, Discritization, round off, first order wave equation, stability of hyperbolic and elliptic equations, conservative property, upwind scheme, transportive property, artificial viscosity, examples.

UNIT II **(07)**

Applied Numerical Methods:

Numerical integration, Guass – Chebychev & Guass - Langragge quadratures, roots of a function, solution of a simultaneous linear algebraic equation, interactive schemes of matrix inversion-direct methods for matrix inversion, conjugate gradient algorithm, and examples.

UNIT III **(07)**

Finite Difference Applications in Heat Transfer:

Introduction, Steady heat conduction in rectangular geometry, examples, control volume formulation, cylindrical and spherical geometry's transient conduction problem, finite difference in convection heat transfer; examples.

Section II

UNIT IV **(07)**

Solution of Navier-Stokes equations for Incompressible flows:

Introduction, Staggered grid, solution to the unsteady N-S equations, MAC algorithm: method and formulation, higher order upwind differencing examples, solution of energy equation, Simple formulation: basic rules, Discritization convection-diffusion equation, central difference approximation, exact solution and exponential scheme, power law scheme,

Two dimensional incompressible viscous flows, incorporation of upwind scheme, Discritization error, application to curvilinear geometry, surface pressure and drag examples.

UNIT V **(07)**

Fluid flow problems in IC Engines:

Flow through manifolds (single and multi cylinder engines), valves and ports-Elements of air motion in engines viz. Swirl, squish, tumble and turbulence. Basics of turbulent flow-Turbulence modelling and characterization of turbulence mixing. Outline of fluid dynamic models-application of available commercial codes to engine process with and without chemical reactions.

UNIT VI **(05)**

Viscous Flow:

Analysis of two dimensional incompressible viscous flow inside a Lid Driven Cavity, Algorithms to obtain flow field by solving system of coupled equations.

TERM WORK

1. Introduction to operating systems and high-level programming languages.
2. Use of symbolic software packages like MATLAB, MAPLE and MATHEMATICA.
3. Hands-on practice using computational fluid dynamics related software such as COMSOL, Virtual Lab and FLUENT.
4. Code development for problems involving solid mechanics, fluid mechanics and heat transfer.
5. **Mini project based on application of CFD in automated system and presentation on the same at the end of semester.**
   Note- The term- work will be accessed on the basis of completion of above mini project.

REFERENCE BOOKS

1. Computational Fluid Flow & Heat Transfer, K. Muralidhar, T. Sundarajan, Nervosa Publishing House, New Delhi, 2012.

2. Computational Fluid Dynamics, John, D. Anderson. J R, McGraw Hill, 2011.
3. Computational Fluid Dynamics, C. T. Shaw, Prentice Hall India, 1992.
4. Numerical Heat Transfer and Fluid Flow, S. V. Patankar, McGraw Hill, 2012.
5. Computational Fluid Mechanics and Heat Transfer, Anderson D.A., Tennehill J.C. and Pletecher R.H., Hemisphere, 1984.
6. An introduction to computational fluid dynamics, H.K.Versteeg and W. Malalasekera, Pearson Education, 2007.
7. Computational Fluid Dynamics, Roache, P.J. Hermosa, 1982.
8. Computational Fluid Dynamics for Engineers-Volume I, Hoffmann Klaus. A., Engineering Education System, Wichita, 1993.
9. `Numerical Computation of Internal and External Flows', Charles Hirsch, Vol.1 (1988) and Vol.2 (1990), John Wiley & Sons.
10. `Computational Fluid Mechanics and Heat Transfer Richard Pletcher, John Tannehill and Dale Anderson, CRC Press, 3rd Edition 2012.

B.E. (Mechanical and Automation) – Part I

4. DESIGN OF JIGS AND FIXTURES (ELECTIVE-I)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To introduce the students to the design practices of tooling (Jigs and Fixtures) and die design for presswork
2. To provide a comprehensive exposure to design of Jigs and fixtures and its significance in Industries.

Course Outcomes:

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

1. Illustrate production processes with Jig and Fixture design and manage manufacturing functions in a better way.
2. Explain design and development by means of jig and fixture and tooling.

Section I

UNIT I **(07)**

Introduction to Jigs and Fixtures:

Necessity, applications and types, basic concept of jig sand fixtures for different manufacturing processes, dependency of jig and fixture design on operation sequence.

Location & clamping system: Principles, types, applications, locating pins, pads, diamond pins, adjustable supports, Vee & post locators, clamping system - principle, types, screw clamp, strap, lever, hinge type, cam operated, toggle clamps, centralizer & equalizer clamp, multiple clamping, quick acting clamps, pneumatically operated clamps.

UNIT II **(07)**

Design of Jigs:

Principles of jig design, types of jigs- plate, template, box, channel, sandwich, latch, tumble, turn-over, tumble jig etc., types of bushes, selection of bushes and liners, construction of jig and fixture bodies, use of standard parts.

UNIT III **(07)**

Design of fixtures:

Principles of fixture design, types of fixtures- gang, straddle, vertical, slot, string milling fixture etc, selection of the suitable type, design of milling fixtures, use of setting block, T-bolts etc, design of turning fixture for lathe Indexing System.

Section II

UNIT IV **(07)**

Introduction to press tools:

Dies, punches, types of presses, types of dies, simple, compound, combination and progressive dies, press tools for operations like blanking, piercing, drawing, shaving, trimming, etc.

UNIT V **(07)**

Design of die set for cutting operations:

Theory of metal cutting, cutting force and lank holding force estimation, punch and die clearance, scrap strip layout, design of punches, design of dies, pilots, strippers, stock stops, finger stops, auto stops, center of pressure, selection of die set.

UNIT VI **(05)**

Design of drawing die:

Blank size determination, no. of draws, stage wise achievement of drawn component, stage wise component drawings, drawing radii and clearance, drawing forces, defects in drawing. Miscellaneous dies like-cut off dies, trimming, shaving, bulging, rubber, lancing, slitting, horn type, side cam dies, bending, forming, curling dies. (Theoretical treatment only).

TERM WORK

1. Study of various elements of jigs and fixtures.
2. Design and drawing of two drilling / reaming jigs. (Details of at least one sheet showing manufacturing drawing with tolerances, material specification and heat treatment.)
3. Design and drawing of two milling fixtures. (Details of at least one sheet showing manufacturing drawing with tolerances, material specification and heat treatment).
4. Design and drawing of one progressive die.
5. Design and drawing of one drawing die**.**

6. At least one industrial visit to study industrial practices related to the subject and submission of the visit report.

REFERENCE BOOKS

1. Tool designs, Cyril Donaldson, George H. LeCain, V. C. Goold, Joyjeet Ghose, Tata McGraw-Hill Education, 2012.
2. Tool Design, Pollock, Reston Pub. Co. Inc. 2006.
3. An Introduction to Jig& Tool Design, M.H.A. Kempster (ELBS).
4. Fundamentals of Tool Design, Ed. Frank Wilson, ASTME (TMH).
5. Jigs and Fixture Design Manual, Henirkson, Industrial Press, Newyork, 2008.
6. Handbook of Die Design- Suchy, McGraw Hill.
7. Die Design Fundamentals, J. R. Paquin, R. E. Crowley, Industrial Press Inc.
8. Jigs and Fixture, P. H. Joshi, Tata Mc-Graw Hill Pub. Co. 3rd Edition 2007.
9. Techniques of Press Working of Metals, Eary and Reed
10. CMTI Machine Tool Design Handbook, TMH
11. Design Data Handbook –PSG College of Tech., Coimbatore, Reprint 2010.
12. Jigs and Fixture Design, E.G. Hoffman, Cengage Learning, 5th Edition, 2008.

B.E. (Mechanical and Automation) – Part I

4. REFRIGERATION AND AIR CONDITIONING (ELECTIVE-I)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To revise the fundamentals of applied thermodynamics and explain its application to refrigeration and air conditioning.
2. To illustrate different refrigeration systems, refrigerants & their commercial applications.
3. To explain the selection of refrigeration equipment, refrigerants and insulation materials according to application.
4. To demonstrate different processes, properties of moist air and use of Psychometric chart in air-conditioning systems.
5. To demonstrate various problems regarding control system and devices used in vapor compression system, psychometric and air conditioning.
6. To explain different air distribution systems for various applications.

Course Outcomes:

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

1. Apply the fundamentals of refrigeration and air conditioning systems.
2. Select the refrigeration equipments for refrigeration and air conditioning system.
3. Analyze and distinguish the problems for various control systems and processes in refrigeration and air conditioning.
4. Compare important thermodynamic and environmental properties influencing refrigerant selection for various applications.
5. Evaluate and analyze various refrigeration and air conditioning problems using psychometric chart, steam table.
6. Explain factors affecting human body and select suitable air conditioning system according to environmental condition.

Section I

UNIT I **(02)**

Review of Thermodynamics:
Laws, General equations, Processes, Equations applied to processes.

UNIT II **(09)**

A) Basic Refrigeration Cycles:
Carnot cycle, Reversed Carnot cycle, Simple Vapor compression cycle, sub-cooling, superheating, Liquid to suction vapor heat exchanger, Calculations and performance of above cycles, Actual vapor compression cycle, Bell Coleman - Reversed Bryton cycle, Air cycles for air craft's (Descriptive Treatment).

B) Refrigerants:
Classification, Desirable Properties like Thermodynamic, physical,& chemical. Comparison among commonly used refrigerants, Selection of Refrigerants, Effect on Ozone depletion and global warming, Alternative Refrigerants.

UNIT III **(08)**

A) Multi pressure System:
Removal of flash gas, Flash inter-cooling, Water-cooling, Multistage, Multi-evaporator & Cascade System, Introduction to cryogenic engg& application, Claude cycle, Linde Cycle.

B) Vapor Absorption System:
Aqua Ammonia system, Lithium Bromide water vapor system, Crystallization, Coefficient of Performance, Comparison with Vapor Compression cycle. (Descriptive treatment only)

UNIT IV **(03)**

Refrigeration Equipments:
Compressor, Condenser, Evaporator, Expansion devices, temperature control systems and devices ,Types, selection, use of insulation, methods of charging and testing, Non conventional methods of refrigeration like vortex tube, Pulse Tube.

Section II

UNIT V **(08)**

A) Psychrometry:
Moist air as a working substance, Psychometric properties of air, Use of Psychometric tables and charts, Processes, Combinations and Calculations, ADP, Coil Condition lime, Sensible heat factor, Bypass factor, Air washer and it's applications.

B) Comfort:
Thermal exchange between human body and environment, factors affecting comfort, effective temperature comfort chart, ventilation requirements.

UNIT VI **(09)**

A) Heating and Cooling Load Calculation:

Representation of actual air conditioning process by layouts & on psychometric charts, Load analysis RSHF, GSHF, ESHF, Enumeration & brief explanation of the factors forming the load on refrigeration and air conditioning systems, Energy requirements of different types of air conditioning systems, Energy conservation in air conditioning.

B)Air Distribution System:

Re-circulated air, Ventilation air, Duct work, Use of friction loss & rectangular equivalent of round duct chart, duct system, principle of duct sizing, and air distribution it's norms, diffusers, dampers, layout, duct systems for theaters, auditorium, hospitals, assembly shop, etc.

TERM WORK :(Any 6 assignments and minimum 3 trials of the following experiments.)

1. Study of various methods of refrigeration and its applications.
2. Study and demonstration of refrigeration system. (Water cooler refrigeration, chiller, ice plant and cold storage).
3. Study and demonstration on automation in air conditioning systems (Unitary and central air conditioning / system)
4. Study and demonstration of controls in refrigeration.
5. Visit to central air conditioning or cold storage or dairy plant or ice plant related with refrigeration & air conditioning system.
6. Study or demonstration of dehydration, charging leak testing and testing of refrigeration system with trouble shooting.
7. Study or demonstration or trial on vapor absorption system.
8. Study / Trial on heat pump.
9. Market survey of various refrigerating & air conditioning systems which include the equipment's with related specifications, manufacturer, cost(minimum 3 to 4 equipment's)
10. Study & trial on Cascade refrigeration system.
11. Trial on refrigeration system.
12. Trial on air conditioning system.
13. Trial on ice plant.
14. Trial on Cascade system.

REFERENCE BOOKS

1. Principles of Refrigeration - Roy J. Dossat, Thomas J. Horan, Prentice Hall, 5th Edition, 2001.
2. Refrigeration and Air Conditioning, Stoker, Paperback, 1983
3. Refrigeration and Air Conditioning - C. P. Arora, Tata McGraw-Hill Education, 2001.
4. Refrigeration and Air Conditioning - Arora Domkundwar, Dhanpat Rai & Co. Ltd, 2000.
5. Refrigeration and Air Conditioning - V. K. Jain, S. Chand & company, 1986.
6. Air Conditioning Principles and Systems, Edward G. Pita P.E., Prentice Hall, 4th Edition,2001.
7. Air Conditioning Applications and Design - W. P. Jones, 2nd Edition, 1996.

9. Thermal environmental engineering, Thomas H. Kuehn (Author), James W. Ramsey (Author), James L. Threlkeld, 3rd Edition, 1998.

B.E. (Mechanical and Automation) – Part I

4.COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING (ELECTIVE-I)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To develop a competency in engineering design by modern computational methods
2. To understand the methodologies for development of CAD/CAM/CAE Software and its customization.
3. To understand different types of modeling techniques.
4. To get acquainted with three dimensional modeling software's for preparing individual parts and assembly of the same.
5. To get acquainted with preparation of two dimensional manufacturing drawing of individual parts.
6. To study the advanced manufacturing methods like rapid prototyping.
7. To study advanced material handling systems.

Course Outcomes:

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

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects and store and manage data.
3. Prepare part programming applicable to CNC machines.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for analysis of a complex engineering component.

Section I

UNIT I **(02)**

Introduction:

Application of computers to design, benefits of CAD, conventional design versus CAD. Standards in CAD, Graphics and computing standards, data exchange standards, design database interfacing design and drafting, Mechanical assembly, Introduction to CAD software: Capabilities of various commercially available software in the area of CAD such as CATIA, Solid Edge, and Solid Works etc.

UNIT II **(07)**

Solid modeling:

Solid modeling, Rapid prototyping, Data exchange, Documentation, Customizing, Solid modeling systems. Assembly modeling, Surface modeling, Drafting, Introduction to kinematics

UNIT III **(06)**

Rapid prototyping:

Rapid prototyping systems, Selective laser sintering - Working principles - Advantages and limitations - Sterolithography - Working principle Applications, advantages and limitations - Case studies, Other systems**,** laminated object modeling - Waving principles, applications - Advantages and limitations - Fused deposition modeling - Direct shell production casting - Applications.

UNIT IV **(05)**

Re-engineering tools and Implementation:

Analytical and process tools and techniques - Information and communication technology - Enabling role of IT, RE-opportunities, process redesign - cases. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability. Introduction to Product Lifecycle Management (PLM) - Concept, Implementation, Case Study.

Section II

UNIT V **(10)**

A) Machine Centers:

Principles of Numerical control, Types of CNC Machine Tools, Features of CNC Systems, Direct numerical control (DNC), Elements of CNC viz. Ball screws, rolling guide ways, structure, drives and controls, standard controllers, Manual part programming with APT, Virtual machining. Machining Centers and Interpolators.

B) CNC Programming and CNC allied machines:

Types, Manual Part Programming, Canned Cycle, Offset, APT.CNC Presses, CNC-EDM, CNC-WEDM, CNC-CMM, CNC Molding Machines, Automated Welding.

UNIT VI **(10)**

A) Automated Material Handling:

Types of Material Handling System, Configuration, Equipments, Elements AGVS, ASRS, Carousal System, Design & Analysis of Material Handling System, Conveyors, Stores& Storage Systems.

B) Automated Assembly &Inspection:
Principles & Methods, Sectors Automated inspection principles and methods – sectors techniques for automated inspection - techniques for automated inspection – contact and non-contact inspection methods – in processes automated measuring methods, machine vision – optical inspection methods. Automatic identification.

TERM WORK

1. Introduction to Modeling software:
   - 2D drawing and drafting using sketcher workbench – 2 drawings
   - 3D modeling and drafting using 3D features – 5 models
   - Assembling and drafting of 2 assemblies with interference checking.
2. Computer aided manufacturing:
   Part programming and part fabrication on CNC trainer (Turning / Milling) – 2 components.

REFERENCE BOOKS

1. "CAD/CAM Computer Aided and Manufacturing", Mikell P. Groover and Emory W. Zimmers, Jr., Eastern Economy Edition
2. "CAD/ CAM, Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, Tata McGraw Hill Publications, 3rd Edition, 2007.
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, Eastern Economy Edition
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, Pearson Education
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, New Age International Publishers
6. "CAD/CAM Principles and Applications" by P.N. Rao, Tata McGraw Hill Publications
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, McGraw Hill Book Co. Singapore.
8. Computer Integrated Design and Manufacturing, David Bedworth, McGraw Hill.
9. "CNC Machines", B.S. Pabla and M. Adithan, New Age International Publishers.
10. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, Tata McGraw Hill, 2010.
11. "CNC Technology and Programming", Krar, S., and Gill, A., McGraw Hill publishers.
12. "Computer Integrated Manufacturing- An Introduction with Case Studies", Paul G. Ranky, Prentice Hall International, 2008.
13. "Flexible Manufacturing Systems" by H.K. Shivanand, M.M. Benal, V.Koti, New Age International Publishers
14. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., Prentice-Hall of India Pvt. Ltd
15. "Rapid Prototyping: Principles and Applications" C.K. Chua, K.F.Leong, C.S. Lim World Scientific Publishing
16. "Rapid Prototyping and Manufacturing", P. F. Jacobs, Society of Manufacturing Engineers.

B.E. (Mechanical and Automation) – Part I

5.NANO TECHNOLOGY (ELECTIVE-II)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To acquaint learner with fundamentals of nanotechnology
2. To study applications and implementation of nanotechnology

Course Outcomes:

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

1. Discuss concept of nanotechnology
2. Understand the top-down and bottom-up approaches to nanotechnology
3. Understand nano-manufacturing methods
4. Apply design concepts for nano- scale products or processes.

Section I

UNIT I **(06)**

Introduction:

Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nano structured materials- nano particles-quantum dots, nano wires-ultra-thin films multilayered materials. Effect of nano scale dimension on various properties structural, chemical thermal, mechanical Electronic, Optical, Magnetic and electronic properties.

UNIT II **(06)**

General Methods of Preparation:

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapor phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III **(08)**

Nanomaterials:

Nano forms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nano tubes (SWCNT) and Multi wall carbon nanotube (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nano metal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nano clays functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

Section II

UNIT IV **(08)**

Characterization Techniques:

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nano indentation Concept, Implementation, Case Study.

UNIT V **(07)**

Applications:

Nano Info Tech: Information storage- nano computer, molecular switch, super chip, nano crystal, nano filters ,Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nano particles for sun barrier products - In Photostat, printing, solar cell, battery, application of nano composites.

UNIT VI **(05)**

Applications of Nanotechnology In Medicines:

Nan biosensors – Electronic Nose – Photo Dynamic Therapy – Molecular Motors – Protein Engineering.

TERM WORK

It shall consist of six exercises based on the above syllabus.

REFERENCE BOOKS

1. Transports in nanostructures, David ferry, Cambridge University Press, 2000.
3. Electron Transport in mesoscope Systems, S.Datta, Cambridge University Press, 1995
4. Introduction to Mesoscope Systems, Y. Imry, Cambridge University Press, 1997
5. Single Charge Tunneling, H.Grabert and M. Devoret, Plenum Press, 1992.
6. Quantum Transported Semiconductor Nanostructures, Beenakerand Van Houten, 44, eds., Academic Press, 1991.
7. Handbook of Microlithography, Micromachining & Micro fabrication, P. Rai-Choudhury, SPIE, 1997.
8. Nanosystems: Molecular Machinery, Manufacturing & Computation, K E Drexler,
   (Wiley), 1992.
9. Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence will transform the World, Prometheus, 2002.

B.E. (Mechanical and Automation) – Part I

5.INDUSTRIAL PRODUCT DESIGN (ELECTIVE-II)

Teaching Scheme
Lectures: 3 Hrs/ Week

Examination Scheme
Theory :100 Marks

Practical: 2 Hrs / Week Term work: 25 Marks

Course Objectives:

1. To know the concept of product development.
2. To understand the product architecture.
3. To know the principles of DFMA.
4. To understand the ergonomic considerations for the product.
5. To understand the hazards and safety about the product.

Course Outcomes:

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

1. Design the product considering principles of DFMA.
2. Apply ergonomic concept while designing the product
3. Consider the safety to avoid accidents.

Section I

UNIT I **(02)**

Introduction:

Challenges of product development; Successful product, development Quality aspect of product design; Market Research; Survey

Identify customer needs and Product Planning Processes. Product specifications: Process of setting specifications. Concept generation–selection–testing

UNIT II **(08)**

Product Architecture:

Implication of architecture, establishing the architecture, related system level design issue. Industrial design: Overview

UNIT III **(10)**

Design for manufacturing and assembly:

Tolerancing, design of gauges; Design for environment; Robust design. Prototyping; Engineering Materials. Concurrent engineering Product costing, value engineering, Aesthetic concepts; visual effects of form and color.Product data management. Innovation and Creativity in Product Design. Case Studies.

Section II

UNIT IV **(09)**

A) Ergonomics and Industrial Safety (EIS):

Introduction General approach to the man-machine relationship-workstation design-working position and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems.

B) Control and Displays: configurations and sizes of various controls and displays: design of controls in automobiles, machine tools etc., - design of instruments and controls.

C) Ergonomics and Manufacturing: Ergonomics and product design; ergonomics in automated Systems; Anthropomorphic data and its applications in ergonomic design; limitations of anthropomorphic data - use of computerized database.

UNIT V **(06)**

Safety & Occupational Health and Environment:

Application of Ergonomics in industry for Safety, Health and Environment Control: Prevention and specific safety measures for manufacturing and processing industry – safety in the use of machines, precaution for certain chemical types of industry like foundry, process industry, and chemical industry.

(05)

UNIT VI

Environmental Safety and ISO 14000 Systems, Occupational Health – Health and Safety considerations; Personal protective Equipment.

TERM WORK

Eight assignments with case studies on above topics.

REFERENCE BOOKS

1. Product Design and Development: Karl T. Ulrich, Steven G. Eppinger; Irwin McGraw Hill.
2. Product design and Manufacture, A.C. Chitale and R.C. Gupta; PHI
3. New Product Development, Tim Jones, Butterworth, Heinemann, Oxford, 1997.
4. Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, CRC Press, 3rd Edition, 2010.
5. Product Design: Otto and Wood; Pearson education, 2001.
6. Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988.
7. Applied Ergonomics, Hand Book: Brian Shekel (Edited) Butterworth Scientific, London 1988.
8. Introduction to Ergonomics – R.C. Bridger, McGraw Hill Pub.
9. Human Factor Engineering – Sanders & Macormick, McGraw Hill Publications.

B.E. (Mechanical and Automation) – Part I

5.TOTAL QUALIY MANAGEMENT (ELECTIVE-II)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To know the concept of Total Quality and role of Q.A.
2. To understand Planning and Controlling techniques for Quality.
3. To know the reliability approach for Quality.
4. To realize Benefits of Taguchi's Quality philosophy.
5. To understand the key issues and some popular approaches to TQM implementation.
6. To understand the current trends in TQM.

Course Outcomes:

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

1. Explain the evaluation, meaning, techniques and philosophy of Total Quality Management (TQM) with reference to the key leader's theories.
2. Explain and distinguish quality planning, quality control and quality assurance concepts and its functions.
3. Categorize the processes in measuring, analyzing and controlling the quality characteristics with the help of quality control tools.
4. Differentiate the customers, customer feedback, organizational structures, internal departments, their role and responsibilities in TQM.
5. Compare the dimensions of quality in product and service organizations and the challenges inherent in measuring quality in service organizations.
6. Explain Quality Awards and Quality Certification like ISO series of standards with its importance.

Section I

UNIT I **(06)**

Quality Assurance System:

Concept of total quality, role and objectives of Q.A., Q.A. cycle, Process approach to Q.A. (input-process-output), information feedback, Significance of feedback and field complaints analysis in Q.A ., significance of Internal customer approach in defect prevention program for Q.A.

UNIT II **(07)**

Planning and Controlling Techniques for Quality

Planning for Quality: The dimensions of Quality (quality of Design, conformance, performance and service) Specifications of quality dimensions, quality planning activities for new products, Advanced Product Quality Planning (APQP), Planning through trial lots, Quality planning with vendors, Vendor control procedures, Vendor rating.

Controlling Techniques for Quality: SPC, Problem solving QC tools, Process capability analysis, Six sigma- concept, need, implementation, DPMO, Gradation.

UNIT III **(07)**

Robust and Reliable product approach for Quality:

Product and System reliability, Basic concepts, Prediction and evaluation of parallel, series and combined system reliability, Reliability tests (life testing , burn-in test, accelerated life testing) FMEA and FTA Taguchi's quality philosophy, System design, Parameter design, Tolerance design, Orthogonal arrays, S/N ration, loss functions.

Section II

UNIT IV **(06)**

Principles and Approaches to TQM:

Basic Concepts: Concept and definition of TQM, TQM and traditional management approach, Principles, Models (TQM pyramid – Okland, Integrated model-shoal et.al. The building blocks of TQM-Zaire, The house of TQM-Kano), Characteristics and benefits of TQM.

Approaches to TQM: Deming's approach, Juran's triology, Crosby and quality improvement, Ishikawa's CWQC, Feignbaum's theory of TQC, Schnberger's action agenda for manufacturing excellence.

UNIT V **(07)**

The Essentials of TQM:

Customer focus- Customer perception of quality, Customer satisfaction, Kano's model of satisfaction, Customer retention.

TQM leadership - role and commitment and accountability of leadership, Quality policy and objectives, Organizational structure for TQM, Role of HR in TQM, Training for TQM, Developing quality culture.

Tools and Techniques for TQM

5-S campaign, TEI, Quality circles, QFD, FMEA and FTA, Poka-yoke, KAIZEN.

UNIT VI **(07)**

Current trends in TQM

TQM in Service Sector: Definition and meaning and service, Problems in defining service quality, Attributes of service quality, SERVQUAL model, Implementing TQM in service industries, Measurement system for service quality.

Quality Management Systems:

ISO 9001:2008 Series of Standards Structure of ISO 9001:2008 series standards, Clauses, Contents, Interpretation and Implementation, Audit

Sector specific Standards: AS 9100, ISO/TS 16949, TL 9000, Quality awards: national and international quality awards, criteria and case studies.

TERM WORK

- Six assignments based on the syllabus
- Any four case studies through industrial visits

REFERENCE BOOKS

1. "Total Quality Management", Dale H. Bester filed, et.al. Pearson Education Asia

2. "Total Quality Management", Dr. Poornima Charantimath, Pearson Education Asia 2nd Edition, 2012.
3. "Managing Quality", Barrie G. Dale et.al., Wiley India P. Ltd.
4. "Handbook of Total Quality Management", Dr. R.P. Mohanti, R.R. Lakhe, Jaico Publishing House, 2007.
5. "Practical Reliability Engineering", Patrick D.T. Connor, Wiley India P. Ltd. 4th Edition, 2009.
6. Quality Planning and analysis, Juran J.M & Gryna.
7. " Inspection, Quality control and Reliability" Sharma S.C., Khanna Publishers
8. "Total Quality Control", Feigenban, McGraw Hill Book Company, New York
9. "Quality Management", Kanishka Bedi, Oxford University Press, 2007.

B.E. (Mechanical and Automation) – Part I

5.MECHATRONICS (ELECTIVE-II)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To enable learners to apply the relevant mechatronics technologies for the design and realization of innovative systems and products.
2. To get acquainted with state –of-the-art signal conditional techniques.
3. To prepare Mechanical Engineering students for advanced graduate studies in Mechatronics.

Course Outcomes:

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

1. Understand the importance of integration of Mechanical, Electronics and Control in the design of Mechatronic system.
2. Understand key elements of sensors and transducers and interfacing the same with problem under consideration through PLC.

Section I

UNIT I **(04)**

Introduction:

Definition of mechatronics. Mechatronics in manufacturing, products and design. Review of fundamentals of electronics.

UNIT II **(06)**

Mechatronics elements:

Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers.

UNIT III

A) Processors and controllers: **(04)**

Microprocessors, microcontrollers, PID controllers and PLCs.

B) Drives and mechanisms of an automated system: **(06)**

Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.

Section II

UNIT IV **(06)**

Design of Mechatronics System

Key elements – Mechatronics Design process –Design Parameters – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety.

UNIT V **(07)**

A) System Modelling

Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design-model transformation-domain-independent description forms-simulator coupling**.**

B) Real Time Interfacing

Introduction-selection of interfacing standards Elements of Data Acquisition & control Systems- Over view of I/O process, General purpose I/O card and its installation, Data conversion process,

Application Software- Lab view Environment and its applications, Vim-Sim Environment & its applications -Man machine interface.

UNIT VI **(07)**

Case Studies On Mechatronic System

Introduction –Fuzzy based Washing machine – pH control system – Autofocus Camera, exposure control– Motion control using D.C.Motor & Solenoids – Engine management systems.– Controlling temperature of a hot/cold reservoir using PID-Control of pick and place robot – Part identification and tracking using RFID – Online surface measurement using image processing.

Term work

Minimum eight assignments on above topics.

Reference Books

1. Mechatronics, W. Bolton, Pearson education, 4th Edition, 2011.
2. Mechatronics, Mahalik, TATA McGraw Hill, 2003.
3. Programmable logical controller, Hackworth, Pearson Education.
4. Microprocessor 8085, R.Gaokar, Pehram International Publishing House, 5th Edition, 2005.

5. Mechatronics, AppuKuttam, Oxford publications, 2007.
6. Automated Manufacturing systems, S. Brain Morris, McGraw Hill, 2006.
7. Mechatronic Systems: Modeling and simulation with HDL's, Georg Pelz, John Wiley and sons Ltd, 2003.
8. "Mechatronics System Design", Devdasshetty, Richard A. Kolk, Thomson Learning Publishing Company, Vikas publishing house, 2001.
9. Mechatronics: Electronic Control systems in Mechanical and Electrical Engineering, Bolton, 2nd Edition, Addison Wesley Longman Ltd., 1999.
10. Mechatronics Hand book, Bishop, Robert H, CRC Press, 2002.
11. Mechatronics: Electronics in Products and Processes, Bradley, D.Dawson, N.C. Burd and A.J. Loader, Chapman and Hall, London, 1991.

B.E. (Mechanical and Automation) – Part I

6.SEMINAR

Teaching Scheme	**Examination Scheme**
Seminar work: 2 Hrs / Week	Term work: 25Marks

Topic Selection:
Any advanced and emerging area of Mechanical and Automation engineering may be selected as a seminar topic. The seminar may also be based on proposed potential project work.

Seminar Load:
Maximum 7 students in one batch shall work under one Faculty Member.

Seminar Report:
Seminar report should be of 25 to 35 pages. For standardization of the seminar report, the following format should be strictly followed.

1.Page size	: Trimmed A4
2. Top Margin	: 1.00 Inches
3. Bottom Margin	: 1.32 Inches
4. Left Margin	: 1.5 Inches
5. Right Margin	: 1.0 Inches
6. Para Text	: Font - Times New Roman; 12 point
7. Line Spacing	: 1.5 Lines
8. Page Numbers	: Right aligned and in footer.
9.Headings	: Font Times New Roman; 12 point New Times Roman, 14 point, Boldface
10.Certificate	: All students should attach standard format

The entire seminar should be documented as one chapter. References should havethe following format.

For Books:

1. "Title of Book"; Authors; Publisher; Edition;

For Papers:
1. "Title of Paper"; Authors; Journal/Conference Details; Year.

Marks:
1 Seminar Report: 10
2 Presentation: 15

All students have to present their seminars individually in front of the departmental expert panel of faculties.

B.E. (Mechanical and Automation) – Part I

7.PROJECT

Teaching Scheme	**Examination Scheme**
Project: 3 Hrs / Week	Term work: 50Marks

Objectives:

1. To provide an opportunity to students to do work independently on a topic/ problem selected by them and encourages them to think independently on their ownto bring out the conclusion under the given circumstances in the budget provided with the guidance of the faculty.
2. To encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Project Load:
Maximum 9-10 students in one batch, involving 03 project groups shall work under one Faculty Member. Group of one student is not allowed under any circumstances.

Project Selection :
Project work shall be based on any of the following:
1. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
2. Experimental verification of principles used in Mechanical Engineering Applications.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.

Project Term Work: 50 Marks
The term work under project submitted by students shall include:

1 Synopsis: 15Marks
The group should submit the synopsis in following form.
1. Title of Project
2. Names of Students
3. Name of Guide
4. Relevance
5. Present Theory and Practices
6. Proposed work
7. Expenditure
8. References

The synopsis shall be signed by the each student in the group, approved by the guide and

endorsed by the Head of the Department.

2 Work Diary: 10 Marks

A Work Diary to be maintained by group and countersigned by the guide weekly.
The contents of work diary shall reflect the efforts taken by project group for,

1. Searching suitable project work
2. Brief report preferably on journals/ research or conference papers/ books or literature Surveyed to select and bring out the project.
3. Brief report of feasibility studies carried to implement the conclusion.
4. Rough Sketches/ Design Calculations, etc.

3 The performance of the individual student is to be assessed by internal expert panel of minimum 3 faculties chaired by project guide. The internal expert panel can analyze the work progress through worksite visits/presentation. (**25 marks**)

B.E. (Mechanical and Automation) – Part I

8.INDUSTRIAL TRAINING

Examination Scheme
Term work: 50Marks

TRAINING REPORT:

Industrial training of minimum two (2) weeks should be done after T.E. (II) in summer vacation and its assessment will be done in B.E. (I) –Sem. VII based on report submitted. Work load of the assessment through presentation can be assigned to the respective project seminar guide of the student.

The report should be of about 30 pages. For standardization of the report, the following format should be strictly followed.

1.Page size	: Trimmed A4
2. Top Margin	: 1.00 Inches
3. Bottom Margin	: 1.32 Inches
4. Left Margin	: 1.5 Inches
5. Right Margin	: 1.0 Inches
6. Para Text	: Font - Times New Roman; 12 point
7. Line Spacing	: 1.5 Lines
8. Page Numbers	: Right aligned and in footer.
9.Headings	: Font Times New Roman; 12 point New Times Roman, 14 point, Boldface
10.Certificate	: All students should attach standard format

The entire seminar should be documented as one chapter. References should havethe following format.

1. “Name of Industry with address along with completed training certificate”
2. Area in which Industrial training is completed.

MARKS
Training Report assessment: 10
Presentation performance : 15

Every student has to present his report individually in front of the internal expert panel of minimum 3 faculties chaired by project guide.

B.E. (Mechanical and Automation) – Part II

1.INDUSTRIAL ENGINEERING

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To introduce the students to the concept of integration of various resources and the significance of optimizing them in manufacturing and allied Industries.
2. To acquaint the students with various productivity enhancement techniques.
3. To introduce the concepts of various cost accounting and financial management practices as applied to industries.

Course Outcomes:

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

1. Illustrate the need for optimization of resources and its significance in manufacturing industries, in order to enhance overall productivity.
2. Develop capability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. Manage and implement different concepts involved in methods study and understanding of work content in different situations.
5. Describe different aspects of work system design.
6. Identify various cost accounting and financial management practices widely applied in industries.

Section I

UNIT I **(03)**

Introduction:

Definition, Scope, Responsibilities, Important contributors to I.E., Tools and techniques of I.E.

UNIT II **(09)**

Production Planning and Control

Sales Forecasting – Need, various techniques, Elements of PPC, PPC activity cycle.

A) Planning:

Pre-requisites of process planning, Steps in process planning, Factors affecting process planning, Process selection, Machine selection, Make or buy decision, Line Balancing, Plant capacity, Machine capacity and machine selection planning.

B)Loading & Scheduling:
Machine loading procedure, Concept of scheduling, Single machine scheduling, Job shop scheduling, n jobs one machine, n jobs two machines, two jobs m machine cases.

C)Loading & Scheduling:
Control function and its objectives, mechanism used in effecting production control.

(08)

UNIT III

A) Inventory Management:

Importance & Scope of Inventory Control, Types of Inventory Costs Associated with Inventory, Inventory Control models, Economic Order Quantity, Safety Stocks, Material requirement planning (MRP), Just in time (JIT).

B)Project Management:
Project identification and formulation, Market, Technical economic and financial feasibility, Project scheduling and monitoring – CPM and PERT techniques, Project crashing, Time cost trade-offs.

Section II

UNIT IV **(06)**

A) Facility planning:
Selection of plant location, importance of location, factors influencing plant location, Principles & objectives of plant layout, types of manufacturing systems and layouts, Tools & techniques of Plant layout.

B) Material Handling:
Objectives and principles, Material Handling Equipments, Selection, types and application.

UNIT V **(07)**

A) Productivity &Value Engineering:
Concept, objectives, Factors affecting productivity, Tools and techniques to improve productivity, Productivity measurement. – Models. Value Engineering: Concept, steps, Applications

UNIT VI **(07)**

Work Study:
Definition, objectives and steps Method Study: Recording techniques, principles of motion economy, Cases on methods improvement. Work Measurement: Steps, Performance rating, various techniques, Allowances and standard time estimation, Work Sampling, MOST Techniques.

TERM WORK:

Term work consists of minimum eight exercises from following list.

1. Case study on Industrial Engineering & management
2. Forecasting Methods (At least 2 problems each on Moving average, Exponential Smoothing, Linear Regression)

3. Problems on Make or buy decision, Line Balancing, Plant capacity, Machine capacity and machine selection planning, ABC Analysis
4. Problems on sequencing and scheduling
5. Inventory Model (At least 2 problems each on Basic, shortage, production and quantity discount).
6. Problems on CPM, PERT and crashing.
7. Plant Layout problems. (At least 2 problems)
8. Problems on Productivity measurement.
9. Case study on Value analysis concept
10. Standard time estimation by different methods
11. Case study on Job Evaluation and merit rating.

REFERENCE BOOKS

1. Industrial Engineering and Production Management, Martand Telsang, S Chand & Co, New Delhi, 2006.
2. Work study and Ergonomics, L.C.Jhamb.
3. Industrial Engineering Hand Book, Maynard. H.B, McGraw Hill Book Company, New York, 2002.
4. Production and operation management, J. Adam, R. J. Ebert, Prentice Hall.
5. Production system, planning, analysis and control Riggs. J L., John Weily and sons, New York, 2007.
6. Productivity Engineering and Management, David Sumanth, Tata McGraw Hill, New Delhi.
7. Design and measurement of Work, Motion and Time Study, Bernes, R.L, John Weily India, 2003.
6. Introduction to Work Study, International Labour Office Geneva.
8. Techniques of value Analysis and engineering, Miles Lawrence, McGraw Hill Book Company, New York.
9. Production planning and control, Samuel Eilon.
10. Production and operation management, James Dilworth, McGraw Hill Book Company, New York.
12. PERT and CPM, Srinath. L.S.

B.E. (Mechanical and Automation) – Part II

2.MECHANICAL SYSTEM DESIGN

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Oral Exam: 25 Marks

Course Objectives:

1. To study system concepts and methodology of system design.
2. To study system design of various systems such as brake, clutches and machine tool gearbox.

Course Outcomes:

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

1. Design material handling systems such as hoisting mechanism of brake, clutches.
2. Design engine components such as cylinder, piston, connecting rod and crankshaft from system design point of view.
3. Design pumps for the given applications.
4. Prepare layout of machine tool gear box and select number of teeth on each gear.

Section I

UNIT I **(07)**

Aesthetic and Ergonomic considerations in Design:

Basic types of product form, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgon's color code. Ergonomic considerations-Relation between man, machine and environment. Design of displays and controls. Practical examples of products or equipments using ergonomics and aesthetic design principles.

UNIT II **(05)**

System Approach to Design:-

System Approach to Design; Mathematical model; Lumped system; Dynamic response of lumped & distributed system; Modeling of masses, Elasticity, Inertia, Damping and friction.

UNIT III **(08)**

A) Design of Brakes:

Design consideration in brakes, Band, Internal expanding shoe, External contracting shoe. Thermal considerations and rating of brakes.

B) Design of Clutches:

Design requirement of friction clutches, Selection criteria. Torque transmitting capacity of single plate, Multidisc clutch, Cone clutch and Centrifugal clutch.

Section II

UNIT IV **(06)**

Statistical considerations in Design:

Frequency distribution- Histogram and frequency polygon- Normal distribution- Units of measurement of central tendency and dispersion- Standard variable- Population combination-Design and natural tolerances- Design for assembly- Statistical analysis of tolerances-Mechanical reliability and factor of safety.

(07)

UNIT V

Design of Gear boxes for machine tool applications:
Determination of variable speed range- Graphical representation of speeds- Structural diagram- Deviation diagram- Ray diagram- Selection of optimum ray diagram- Difference between number of teeth of successive gears in a change gear box- Analysis of twelve speed gear box- Compound ray diagram.

UNIT VI **(07)**

Optimum Design:
Objectives of optimum design. Johnsons Method of Optimum Design (MOD), Adequate and optimum design. Primary, Subsidiary and Limit equations- Optimum design with normal specifications of simple machine elements like tension bar, transmission shaft, helical spring. Introduction to optimum design with Langrange multiplier.

TERM WORK

1. A detail design report and A2 size sheet containing working drawing of detail and assembly of Any one of the following;
   a) Design of Machine Tool Gear Box.
   b) Brake design or Clutch design.
2. 2) Assignment based on
   a)Aesthetic and Ergonomic design consideration –case study
   b) System Approach to design.
   b) Problems on Optimum design.

REFERENCE BOOKS

1. Design of machine element, V.B.Bhandari, Tata Mc- Graw Hill Publication, 3rd Edition, 2010.
2. Mechanical Engineering Design, Shigley and C.R.Miscke, Tata Mc- Graw Hill Publication, 9th Edition, 2009.
3. Engineering Design, Dieter G.E., Tata Mc-Graw Hill Publication, 5th Edition, 2012.
4. Design of Machine Tools,S.K.Basu and D.K.Pal, Oxford and IBH Publication.
5. Machine Tool Design, N.K.Mehta, Tata Mc- Graw Hill Publications.
6. Design data, PSG College of Technology, Coimbatore, Reprint 2012.
7. Engineering Optimization Theories and Practice,S.S.Rao, New Age Publication
8. Principles of machine tool, Sen. Bhattacharya, New central book agency.
9. Process Equipment Design, M.V.Joshi , Macmillan Publication.
10. Machine Design, Robert L.Norton, Tata Mc- Graw Hill Publication.
11. Fundamentals of Machine Component Design by Junvinall, Wiley India.
12. Design of Machine Element, M.F.Spotts, Pierson Education.

B.E. (Mechanical and Automation) – Part II

3.ADVANCE CONTROL SYSTEMS

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To introduce the concept of automatic control and method of modeling and analyzing system components including block diagram algebra.
2. To introduce linearization of non-linear functions and use the concept of linearization of operating curves.
3. To introduce response analysis.
4. To introduce techniques for control system design

Course Outcomes:

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

1. Model and represent control systems and their components using block diagram including its simplification.
2. Understand the representation of linearization of operating curves.
3. Understand the system response analysis i.e. steady state and transient response analysis.
4. Understand the techniques for control system design i. e. stability and root locus technique, state space analysis, frequency response analysis.

Section I

UNIT I **(06)**

Introduction to Automatic Control:

Generalized control system types, Control system representation using block diagrams, Role of control systems in industrial automation. Advantages of automatic control systems.

UNIT II **(08)**

Mathematical Modeling of control systems and their components:

Mechanical Translational Systems, Grounded Chair Representation, Rotational Systems, Electrical Elements,

Control system Components-Tachometer, D.C. Servomotor, Hydraulic Servomotor, Stepper Motor, Jet-Pipe Amplifier, Pneumatic Amplifier

UNIT III **(07)**

A) Block Diagram Algebra:

Rules for reduction of block diagram.

B) Linearization:

Linearization of non-linear function, Linearization of operating curves, Steady State Analysis.

C) Transient Response:

General form of transfer function, Concept of poles and zeros, Distinct, repeated and complex zeros. Damping Ratio and Natural Frequency. Transient Response Specifications.

Section II

UNIT IV **(06)**

Stability and Root Locus Technique:

Routh's Stability Criteria, Significance of Root Locus, Construction of Root Loci, General Procedure, Effect of Poles and Zeros on the System Stability,

UNIT V

A) State Space Analysis: **(07)**

System Representation, Direct, Parallel, Series and General Programming, Conversion of State Space Model to Transfer Function.

B) Frequency Response Analysis:

Introduction, Frequency response plots, Frequency response measurements and Performance specifications in the frequency domain.

UNIT VI **(06)**

Control System Applications:

Control systems in industrial automation.

TERM WORK

1. Assignment on response of systems (first, second and higher order systems) to standard input test signals (i.e. Step, Impulse, Ramp, Exponentially decaying and Sinusoidal signals).
2. Mathematical Modeling and electrical analogous systems of control systems such as Liquid Level System, Hydraulic / Pneumatic Pressure System, Thermal System, Gear Train,
3. Study of Control Modes for Pressure / Temperature / Flow / Displacement with practical examples.
4. Assignment on Steady state analysis using Matlab
5. Assignment on Root Locus using Matlab
6. Assignment on State Space Analysis using Matlab
7. Assignment on Frequency Response Analysis using Matlab

REFERENCE BOOKS

1. "Modern Control Engineering", Richard C. Drof and Robart H. Bishop, Pearson Publication 11th edition 2010.
2. Automatic Control Engineering" Norman N. Nise, Wiley Publication, 5th Edition, 2007.
3. "Modern Control Systems": K Ogata, Prentice Hall Publication, 3rd Edition, 2002.
4. "Automatic Control Systems": B.C. Kuo, Willey India Ltd./ Prentice Hall Publication, 7th Edition, 2010.
5. Control System Engineering, R. Anandnatarajan, P. Ramesh Babu, SciTech Publication.

B.E. (Mechanical and Automation) – Part II

4.RELIABILITY ENGINEERING (ELECTIVE - III)

Teaching Scheme
Lectures: 3 Hrs/ Week

Examination Scheme
Theory :100 Marks

Practical: 2 Hrs / Week Term work: 25 Marks

Course Objectives:

1. To introduce principles of reliability in engineering design.
2. To develop understanding of concepts of failures, maintainability and availability of the intended products/systems and services.
3. To develop an ability to analyze field failure data in order to evaluate system reliability.
4. To develop an ability to apply various reliability techniques to solve problems related to aeronautical engineering.

Course Outcomes:

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

1. Explain basics of reliability, maintainability, availability & differentiate among them.
2. Apply fundamentals of reliability to estimate reliability of electronics devices.
3. Analyze field failure data for reliability analysis.
4. Evaluate system reliability using various techniques

Section I

UNIT I **(06)**

Fundamentals and Measures of Reliability:

Brief history, Concepts, Terms and definitions, safety, reliability & quality, life cycle of a system, system effectiveness, Concept of failure, Theory of probability and reliability, laws of probability, Random variables, Discrete and continuous probability distributions.

Measures: Reliability function, Hazard rate function, CDF, PDF, MTTF, MTBF, Median time to failure, mean, mode, median, skewness, kurtosis, Variance and standard deviation, Typical forms of hazardrate function, Bathtub curve and conditional reliability.

UNIT II **(08)**

Basic Reliability Distributions:

Constant failure rate (CFR) model, Binomial distribution, Normal, Poisson, Lognormal, Rayleigh, Weibull, Exponential etc., Fitting probability distributions graphically and estimation of distribution parameters, Renewal and Poisson process, Calculation of R(t), F(t), f(t), $\lambda(t)$, MTTF, t_{med}, t_{mode} for above distributions.

UNIT III **(07)**

Reliability Evaluation of System:

System Reliability block diagram- Series configuration, Parallel configuration, Mixed configurations, redundant systems, standby redundant, High level versus low level redundancy, k-out-of-n redundancy, network reduction and decomposition methods, Cut and tie set approach for reliability evaluation, fault tree analysis (FTA), success tree diagram, failure mode and effect analysis (FMEA), failure modes effects and criticality analysis (FMECA).

Section II

UNIT IV **(07)**

Maintainability and Availability:

Maintainability -Objectives of maintenance, types of maintenance, Concept of maintainability, Measures of maintainability, Mean time to repair (MTTR), Analysis of downtime, Repair time distributions, Stochastic point processes, reliability centered maintenance (RCM).**Availability -**Availability concepts and definitions,

important availability measures, inherent, achieved and operational availability.

UNIT V **(06)**

Reliability Testing and Data Analysis:

Reliability Testing - Reliability life testing, Burn-in testing, Acceptance testing, Accelerated life testing, highly accelerated life testing (HALT) and reliability growth testing.

Data Collection& Analysis - Data collection and empirical methods, Estimation of performance measures for ungrouped compete data, Grouped complete data, Analysis of censored data, Pareto analysis, Goodness-of-fit tests.

UNIT VI **(06)**

Electronic, Software and Human Reliability:

Electronics - Reliability of electronic components, component types and failure mechanism.

Software – Introduction, errors, software testing, hardware/ software interface.

Human reliability analysis (HRA), Introduction, human error in maintenance, impact on system reliability.

TERM WORK

1. Six assignments based on above syllabus.
2. Minimum two case studies on system reliability estimation.

REFERENCE BOOKS

1. An Introduction to Reliability and Maintainability Engineering, Charles E. Ebling, Tata McGraw Hill Education Private Limited, New Delhi, 2004.
2. "Reliability Engineering", L. S. Srinath, East West Press, New Delhi, 1991.
3. "Reliability Engineering: Theory and Practice", Alessandro Birolini, Springer, 2010.
4. "Reliability evaluation of engineering systems: concepts and techniques", Roy Billiton and Ronald Norman Allan, Springer, 1992.
5. "Practical Reliability Engineering", Patrick D.T. O'Conner, David Newton, Richard Bromley, John Wiley and Sons, 2002.
6. "Reliability Engineering: Probabilistic Models and Maintenance Methods", Joel A. Nachlas, Taylor and Francis, 2005.
7. "Life cycle reliability engineering", Guangbin Yang, John Wiley and Sons, 2007.
8. "Case studies in Reliability and Maintenance", W. R. Blischke, D.N.P. Murthy, John Wiley and Sons, 2003.
9. "Maintenance, Replacement and Reliability: Theory and Applications", Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang CRC Press, 2006.
10. Engineering Reliability – New Techniques and Applications", B. S. Dhillon, Chanan Singh, John Wiley and Sons, 1981.

B.E. (Mechanical and Automation) – Part II

4.MANAGEMENT OF MANUFACTURING SYSTEMS (ELECTIVE - III)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To appraise about need and benefits of planning functions related to products and processes.
2. To give exposure to production scheduling and sequencing.
3. To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
4. To impart analytical and problem solving skills necessary to develop solutions for a variety of supply chain management & design problems.
5. To study the JIT & Lean manufacturing process.

Course Outcomes:

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

1. Illustrate production planning functions and manage manufacturing functions in a better way.
2. Develop competency in scheduling and sequencing in manufacturing operations and effect affordable manufacturing lead time.
3. Evaluate various performance measures of supply chain management.
4. Get conversant manufacturing optimization techniques.
5. Manage economics throughout the manufacturing process.

Section I

UNIT I **(07)**

A) Production function:

Production types, objectives and scope of Production Management, Production Planning and Control (PPC)- Definition, elements, Activities of production planning and production control Interrelationship of Production with other functional areas.

B) Production/ Operation strategy:

Relevance, strategy formulation process, order qualifiers and order winners, attributes, strategic options for Operations- Product portfolio, process technology, capacity, Supply chain issues, Measures to ensure Optional Excellence, WCM practices.

UNIT II **(07)**

A) Product Design and Development:

Role of Product Development in competitiveness, Product Life Cycle (PLC), Product Development Process. Tools for efficient product development- FMECA, concurrent engineering, Design for Manufacturing Mass Customization.

B) Process Design:

Determinants of process characteristics- volume, variety, flow. Types of processes, choice of Process, equipment selection, use of BEP in selection process- product matrix. Estimation of Demand- Time series Analysis and causal forecasting techniques, Least square method, moving average and exponential smoothing forecasting method.

UNIT III **(07)**

A) Capacity and Aggregate Planning:

Capacity- Definition, Measure of Capacity, capacity strategies Estimation of number of machines, Overcapacity and under capacity factors, Aggregate Planning, Aggregate Planning Strategies, Pure and mixed strategies, Use of transportation model approach to aggregate planning.

B) Scheduling of Operations:

Loading, scheduling and sequencing, Priority sequencing rules. Sequencing problems, n job 2 machines, n Job '3' machines. Forward and backward scheduling, critical ratio scheduling, Production Control Activities

Section II

UNIT IV **(07)**

A) Supply chain Management:
Concept of supply chain and supply chain management, Manufacturing supply chain, SCM activities Supply chain strategies, Managing supply chain, Measuring supply chain Performance.

B) Just in Time and Lean Manufacturing:
JIT Philosophy, origin and core logic of JIT, Elements of JIT, Kanban System-Design of Kanban containers, JIT. Implementation issues and performance, Lean Manufacturing, Pillars, features and process comparison with Traditional Manufacturing

UNIT V **(07)**

A) Total Productive Maintenance and Replacement:
Introduction, Definition, six big losses, stages of maintenance, pillars stages of TPM Development, Overall Equipment Effectiveness (OEE) computation Replacement - need, Replacement of items whose maintenance cost increases with time (with and without considering time value of money), Replacement of items that fail suddenly.

B) Manufacturing Optimization:
Evaluation criteria for Production/ Manufacturing Optimization, Single stage. Manufacturing Optimization. Basic Mathematical models, Single stage manufacturing model as a function of machine speed, Determining machine Speed, unconstrained optimization.

UNIT VI **(05)**

Managerial / Engineering Economics:
Demand and supply, Demand curve and supply curve, equilibrium of supply and demand, elasticity of demand Production function, factors of production, Isoquants, Least cost. Combination for a given output, Theory of firm Introduction, Review of Time value of money, cash flows, evaluation criteria for capital projects (investment)-Payback period, IRR and BCR.

Term work

For term work six assignments on above topics.

Reference Books

1. Industrial Engineering and Production Management, Martand Telsang, S Chand & Co, New Delhi
2. Industrial Engineering and Management, ArunVishwanath, Scitech publication
3. Maynard. H.B – Industrial Engineering Hand Book, McGraw Hill Book

Company, NewYork
4. Production and operation management, Adam EE , RJ Ebert, Prentice Hall.
5. Production system, planning, analysis and control, Riggs J. L., John Weily and sons, New York.
6. Productivity Engineering and Management, David Sumanth, Tata McGraw Hill, New Delhi.
7. Techniques of value Analysis and engineering, Miles Lawrence, McGraw Hill Book Company, New York.
8. Production planning and control, Samuel Eilon.
9. Production and operation management, James Dilworth, McGraw Hill Book Company, New York.

B.E. (Mechanical and Automation) – Part II

4.NON CONVENTIONAL MACHINING PROCESSES (ELECTIVE - III)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To demonstrate the need for development of newer/ non-conventional machining processes.
2. The student will be able to compare the conventional machining processes with non conventional machining processes with respect to the advantages, applications.
3. The student will be able to identify different energy sources like fluid motion, electric current, high speed electrons, high energy radiation, etc.
4. To analyze the concept, mechanism, parameters associated with the processes.
5. To demonstrate the operational principles, advantages applications, limitations of the various non- conventional machining processes.
6. To selectively select a process /a combination of processes for a specific application/need/situation depending upon the availability of sources.

Course Outcomes:

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

1. Learns and understands, explains the need- history for the development of newer/non-conventional machining process.
2. Demonstrate the comparison between non-traditional machining processes with the traditional machining processes with respect to the different parameters- Energy sources; Economics of the processes; Shape and size of material etc.
3. Analyze the concept, mechanism of material removal with respect to different processes.
4. Different parameters associated with the process, their influence on the machining, will be analyzed.
5. Evaluate advantages, applications and limitations of the various non-traditional machining processes.

Section I

UNIT I **(04)**

Introduction:

History, Classification, comparison between conventional and non-conventional machining, need, process selection.

UNIT II **(07)**

Mechanical processes:

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining Ultrasonic Machining (AJM, WJM, AWJM and USM). Working Principles, equipment used Process parameters – MRR-Variation in techniques used – Applications.

UNIT III **(07)**

Electrical Processes:

Electric Discharge Machining (EDM) - working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.

Section II

(07)

UNIT IV

Chemical & Electrochemical Processes:

Chemical machining and Electro-Chemical machining (CHM and ECM Etchants, maskant techniques of applying maskants-Process Parameters – Surface finish and MRR-Applications. Principles of ECM-equipments-Surface Roughness and MRR Electrical circuit-Process Parameters-ECG and ECH – Applications

UNIT V **(07)**

Thermal Energy Processes:

Laser Beam machining and drilling (LBM), plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques –Applications.

UNIT VI **(07)**

Derived and Hybrid Modern manufacturing Methods:

Derived and Hybrid Modern manufacturing Methods: Introduction of process like rotary ultrasonic machining , electro stream drilling, shape tube electro machining, wire electro discharge machining, electro chemical grinding, electro chemical honing, electro chemical de-burring and electro chemical spark machining.

TERM WORK

1. Minimum Six assignments on above topics.

REFERENCE BOOKS

1. "Advanced Machining Processes", Vijay. K. Jain Allied Publishers Pvt. Ltd., New Delhi, 2007
2. "Nontraditional Manufacturing Processes", Benedict. G.F., Marcel Dekker Inc., NewYork (1987).

3. "Modern Machining Processes" Pandey P.C. and Shan H.S., Tata McGraw-Hill, New Delhi (2007).
4. "Advanced Methods of Machining", Mc Geough, Chapman and Hall, London (1998).
5. "Material and Processes in Manufacturing" Paul De Garmo, J.T.Black, and Ronald.A. Kohser, Prentice Hall of India Pvt. Ltd., New Delhi , 8th Edition, 2001.

B.E. (Mechanical and Automation) – Part II

4.ENGINEERING OPTIMIZATION (ELECTIVE - III)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

Upon successful completion of this course, the student will be able to understand:

1. Basic theoretical principles in optimization.
2. Formulation of optimization models.
3. Solution methods in optimization.
4. Methods of sensitivity analysis and post processing of results.
5. Applications to a wide range of engineering problems.

Course Outcomes:

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

1. Explain an overview of modelling of constrained decision making.
2. Describe different methods of optimization.
3. Develop a mathematical model for a given problem.
4. Solve practical problems using suitable optimization technique.
5. Analyze the sensitivity of a solution to different variables.
6. Use and develop optimization simulation software for variety of industrial problems.

Section I

UNIT I **(07)**

A) Introduction to Optimization:

Engineering applications of optimization, statement of optimization problem, classification of optimization problem.

B) **Classical Optimization Techniques:**

Introduction, single variable optimization, multi variable optimization with no constraint, equality constraint, in equality constraint, convex programming problems.

UNIT II **(07)**

Linear programming:

Applications of Linear Programming, Standard form of linear programming, geometry of linear programming, solutions of system of linear simultaneous equations, pivotal reduction of general system of reduction, simplex algorithms,

Two Phases of the Simplex Method, Duality in Linear Programming, Decomposition Principle, Sensitivity or Post optimality Analysis, Karmarkar's Method, Quadratic Programming.

UNIT III **(07)**

Non-linear programming - One dimensional Minimization methods:

Elimination methods, unrestricted search, exhaustive search, half interval method, golden section method, Interpolation methods - Quadratic Interpolation Method, Cubic Interpolation Method Newton method, Quasi Newton method, secant method, Practical Considerations.

Section II

UNIT IV **(07)**

Non-linear programming - Unconstrained optimization techniques:

Direct search method, random search method, grid search method, Powell's method, Simplex method. Indirect Search method, gradient of functions, descant method, conjugates gradient method, Newton's method, Quasi Newton method.

UNIT V **(07)**

Non-linear programming - Constrained Optimization:

Direct methods - random search method, complex method, sequential linear programming, sequential quadratic programming and generalized reduced gradient method, Indirect method- Transformation Techniques, Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Exterior Penalty Function Method, Convex Programming Problem.

UNIT VI **(05)**

Extrapolation Techniques:

In the Interior Penalty Function Method, Extended Interior Penalty Function Methods, Penalty Function Method for Parametric Constraints, Augmented Lagrange Multiplier Method.

TERM WORK

1. Minimum ten assignments on above topics.

REFERENCE BOOKS

1. Engineering Optimization: Theory & practice, S.S. Rao, New Age International Publication.
2. Optimization for Engineering Design, Kalyanmoy Deb, Prentice Hall of India.
3. Optimization concepts and application in engineering, Besequndle A.D., Pearson.
4. Optimization Concepts and Applications in Engineering, Ashok D. Belegundu, Tirupathi R. Chandrupatla, Prentice Hall of India.
5. Principles of Optimisation Design: Modeling and Computation**,** Panos Y. Papalambros, Douglass J. Wilde.
6. Engineering Optimization, Methods and Applications, A. Ravindran, K.M. Ragsdell and G. V. REKLAITIS, Wiley, 2nd Edition
7. S. S. Rao, Optimization: Theory and Applications, 2nd Edition Wiley Eastern,

1984.
8. Optimization for Engineering Design:Algorithms and Examples, K. Deb, Prentice Hall. India, 1995.
9. Optimization Methods for Engineering Design, R. L. Fox, Addison Wesley, 1971.
10. Introduction to Optimum Design, J. S. Arora, MCGraw-Hill, 1989.

B.E. (Mechanical and Automation) – Part II

5.ENTREPRENEURSHIP DEVELOPMENT (ELECTIVE - IV)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To help the students acquire the basic understanding of different qualities of entrepreneur
2. To develop a managerial perspective to leverage them for competitive advantage.
3. To familiarize the students with the concepts of Business excellence and competitiveness.
4. To apprise the students with the need to meet the current and future business challenges.
5. To prepare the students to understand the current global manufacturing scenario.

Course Outcomes:

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

1. Demonstrate understanding the role and functions of Entrepreneur in carrying out business processes in an industry.
2. Develop the ability to integrate various resources for optimization in the industry
3. Identify the factors of competitiveness and performance measures required to expand the business
4. Draw current Status of Indian Manufacturing scenario and design and develop a roadmap to set up the industry.

Section I

UNIT I **(06)**

Entrepreneurship:

Entrepreneur – Types of Entrepreneurs – Concept of Entrepreneurship, Motivation for Economic Development and Entrepreneurial Achievement Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II **(06)**

Motivation:

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, self Rating, Business Game, Thematic Apperception Test – Stress management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III **(06)**

Business :
Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

Section II

UNIT IV **(07)**

Financing and accounting:
Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT/CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V **(07)**

Support to entrepreneurs:
Sickness in small Business – Concept, Magnitude, causes and consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

UNIT VI **(06)**

Setting up of a small Business Enterprise. Identifying the Business opportunity - Business opportunities in various sectors, formalities for setting up small enterprises in manufacturing and services, Environmental pollution and allied regulatory and non-regulatory clearances for new venture promotion in SME sector. Writing a Business plan, components of a B-Plan, determining Bankability of the project.

TERM WORK

1. Minimum Eight assignments based on above topics.

REFERENCE BOOKS

1. "Entrepreneurial Development", S.S.Khanka, S.Chand& Co. Ltd.New Delhi, 1999.
2. "Enterprenuership: Theory, process and practices", Kuratko & Hodgetts, Thomson learning, 6th edition.
3. "Entrepreneurship" Hisrich R D and Peters M P, Tata McGraw-Hill, 5th Edition 2002.
4. Enterprenuership theory at cross roads: paradigms and praxis", Mathew J Manimala," Dream tech 2nd Edition, 2006.
5. "Entrepreneurship and innovation", Rabindra N. Kanungo Sage Publications, New Delhi, 1998.
6. A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development" Institute of India, Ahmadabad, 1986.

B.E. (Mechanical and Automation) – Part II

5.PRODUCTION PLANNING AND CONTROL (ELECTIVE - IV)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To provide a comprehensive exposure to Production Planning & Control (PPC) and its significance in Industries.
2. To acquaint students with various activities of PPC.
3. To give insight into the ongoing & futuristic trends in the control of inventory.
4. To appraise about need and benefits of planning functions related to products and processes.
5. To give exposure to production scheduling and sequencing

Course Outcomes:

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

1. Illustrate production planning functions and manage manufacturing functions in a better way.
2. Develop competency in scheduling and sequencing in manufacturing operations and effect affordable manufacturing lead time.
3. Manage and control inventory with cost effectiveness.
4. 4. Get conversant with various documents procedural aspects and preparation of orders for various manufacturing methods.

Section I

UNIT I **(07)**

Concepts of PPC:

Manufacturing systems- components and types, need for PPC, functions of PPC, relationship of PPC with other departments. Factors influencing PPC in the organization, manufacturing methods- projects & jobbing products, batch, mass / flow production, continuous / process production. Management policies- planning for meeting demands, work distribution, centralization, Organization of PPC- status of PPC department, internal structure, degree of centralization, PPC as an integrated approach.

UNIT II **(06)**

Activities of PPC:

Prerequisites of PPC- data pertaining to design, equipment, raw materials, tooling, performance standards, lab our& operating systems. Order preparation- works order preparation for various manufacturing methods, subsidiary orders, shop or production orders, inspection orders and stores issue orders.

UNIT III **(06)**

Inventory Control:

Basic concepts of inventory, purpose of holding stock and influence of demand on inventory. Ordering procedures, Two Bin system, ordering cycle, economical order quantity and economical lot size, ABC analysis and reorder procedures. Recent

trends- computer integrated PP systems, JIT system and MRP-I, MRP-II and ERP (only theory).

Section II

UNIT IV **(07)**

Product Planning and Process Planning:

Product planning: product information and its relevance. Problems in lack of product planning. Process planning: Prerequisite information requirement, steps in process planning, process planning in different situations, documents in process planning, machine / process selection & Computer Aided Process Planning. Forecasting: Various Qualitative and Quantitative models, their advantages and disadvantages.

UNIT V **(04)**

Linear Programming Concepts:

Introduction to Linear Programming Problem Formulation, Simplex method. Assignment, Transportation and Transshipment Model.

UNIT VI

Production Scheduling and Sequencing: **(07)**

Inputs for scheduling, loading and scheduling devices, factors influencing scheduling, scheduling techniques, use of Gantt Charts and basic scheduling problems. Product sequencing, dispatching: progress report & expectation of manufacturing lead time technique for aligning completion time &due dates. Project management: concepts of project planning, monitoring and control, elements of network analysis PERT & CPM, cost analysis & crashing.

TERM WORK

1. At least six assignments comprising problems covering different topics from the syllabus.
2. One seminar presentation based on a selected topic from the syllabus.
3. One seminar presentation pertaining to a case study related to PPC.

REFERENCE BOOKS

1. Industrial Engineering and Production Management", Martand Telsang, S. Chand and Company.
2. Production Planning and Control, L. C. Jhamb –Everest Publishing House.
3. Production Planning and Control, W. Boltan, Longman Scientific & Technical.
4. Production Systems- Planning, Analysis & Control, James. L. Riggs-John Wiley & Sons.
5. Manufacturing Planning and Control Systems, Thomas E. Vollman, Willam L. Berryand, Galgotia Publishers
6. Manufacturing Process Planning and Systems Engineering, Anand Bewoor Dreamtech Press
7. Production and Operations Management, S.N.Chary- TMH publishing company
8 "Production Planning Control and Industrial Management", K.C. Jain& L.N.

Aggarwal, Khanna Publishers, 1990.

B.E. (Mechanical and Automation) – Part II

5.NOISE AND VIBRATION (ELECTIVE - IV)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To study basic concepts of noise, vibration and harshness and their effects
2. To study various methods of Vibration control
3. To study and analyze sounds and detection of noise from automobiles.
4. Identify and analyze vibrations and noise coming out of automobiles
5. Investigate level of harm caused by noise and harshness and to provide measures to control it.

Course Outcomes:

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

1. Understand the importance of NVH testing of vehicle components/systems as per standards.
2. Identify sources of noise and describe the methods to minimize it.
3. Perform NVH analysis.
4. Evaluate and interpret NVH test results, identify vehicle noise and vibration root causes and recommend product development solutions.
5. Integrate NVH control techniques at the design stage
6.

Section I

UNIT I **(07)**

Noise and Vibration:

Sources of noise and vibration. Design features, common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and altering role of NVH engineers.

UNIT II **(07)**

Sound and vibration theory:

Sound measurement, human sensitivity and weighting factors, combining sound sources. Acoustics resonance, properties of acoustics materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility, modes of vibration.

UNIT III **(06)**

Test Facilities and Instrumentation:

Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings. Sound intensity technique, acoustic holography, statistical energy analysis.

Section II

UNIT IV **(07)**

Signal processing:

Sampling, aliasing and resolution. Statistical analysis, Frequency analysis, Campbell's plots, cascade diagrams, coherence and correlation functions.

UNIT V **(07)**

NVH control strategies and comfort:

-Source ranking, noise path analysis, modal analysis, design of experiments, optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators, active control techniques**.**

UNIT VI **(05)**

Noise: Sources, Isolation & Control

Major sources of noise, Noise survey techniques, Measurement technique for vehicular noise, Noise due to construction equipments& domestic appliances, Industrial noise sources, Industrial noise control strategies. Noise control at the source, along the path abd at the receiver, Acoustic barriers

TERM WORK

1. At least six assignments on above topics.

REFERENCE BOOKS

1. Fundamental Of Noise And Vibration, Norton M P, Cambridge University Press, 1989.
2. Acoustic Ducts and Mufflers, Munjal M. L., John Wilely, 1987.
3. Noise Control of Internal Combustion Engines, Baxa, John Wilely, 1984
4. Model Testing: Theory and Practice, Ewins D.J. John Wiley, 1995.
5. Dynamic Vibration Absorbers, Boris and kornev, John Wiley, 1993.
6. Mechanical vibrations and Noise Engineering, A.G. Ambekar, PHI learning Pvt. Ltd.2012.
7. Mechanical vibration Practice and Noise Control, V. Ramamurti, Narosa Publishing House, Revised Edition, 2012.
8. Vibration Testing Theory and Practice, Mcconnell K, John Wiley, 1995.
9. Mechanical Vibrations, R. Venchatachalam, PHI Publication, 1st Edition, 2014.

B.E. (Mechanical and Automation) – Part II

5.MICRO-ELECTRO MECHANICAL SYSTEMS (ELECTIVE - IV)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/ Week	Theory :100 Marks
Practical: 2 Hrs / Week	Term work: 25 Marks

Course Objectives:

1. To acquaint with micro electro mechanical systems.
2. To study fabrication methodology, modeling and simulation and characterization techniques of MEMS system.

Course Outcomes:

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

1. Illustrate working and importance of MEMS system.
2. Describe fabrication methodology of MEMS system
3. Illustrate Modeling and Simulation Techniques of MEMS system.
4. Describe Characterization Techniques of MEMS system.
5.

Section I

UNIT I **(05)**

Introduction to MEMS & Applications:

Introduction to Micro-Electro-Mechanical Systems, Applications and Materials, Advantages & Disadvantages of Micro-sensors, and micro-actuators.

UNIT II **(07)**

Sensors and Actuators in Micro-domain:

Concept of Sensors & Actuators, Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys, Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors, Chemical Sensors, Sensors& Actuators for Automotive, Biomedical, Industrial applications, Design of sensor and actuator for few applications such as automobile accelerometer, bimetallic temperature sensor, etc.

UNIT III **(07)**

Fabrication Methods:

Micro fabrication Methods (VLSI Techniques)

Positive and Negative Photo resists, Bulk Micromachining, Surface Micromachining, Etching (Isotropic and Anisotropic), Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques. 3D High Aspect Ratio Techniques

LIGA,AMANDA, Micro stereo lithography, IH-Process, X-Ray Techniques, Ion-beam Lithography, Bulk Lithography (layer-less 3D micro fabrication)

Section II

UNIT IV **(07)**

Modelling and Simulation Techniques :

Scaling Laws, Governing Equations; Modelling of Mechanical Structures via classical methods, Newton's Laws, Thermal Laws, Fluid Flow Analysis; Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling; Modelling of Micro-channel as heat exchanger, accelerometers, micro hinges, compound microstructures. Numerical Methods used

for MEMS analysis.

UNIT V **(10)**

Characterization Techniques

A) Topography Methods (Optical, Electrical and Mechanical Methods)
Microscopy, STM (Scanning Tunneling Microscopes),
SEM (Scanning Electron Microscopes), AFM (Atomic Force Microscopes)

B) Mechanical Structure Analysis
Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric)

C) Interferometry Techniques,
ESPI (Electronic Speckle Pattern Interferometry),
Laser Techniques, Laser Doppler Vibro-meters,

D) Fluid, Thermal and Chemical Techniques
Fluid Flow Pattern Analysis, Electro-chemical Analysis,
PIV Techniques, Spectroscopy**.**

UNIT VI **(03)**

Introduction to Nanotechnology:
CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, Nano-mechanical Systems (NEMS), Nano-tribology, & nano indentation techniques, Domestic and Industrial Applications of nanotechnology

TERM WORK

1. Term work shall consist of 06 design based assignment (one assignment on each module) and two case studies of MEMS.
2. (Design based assignment shall encourage use of recent literature for the development of MEMS or microstructure.)

REFERENCE BOOKS

1. "Microsensors MEMS and Smart devices", Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim John Wiley and sons, Ltd.
2. "An Introduction to Microelectromechanical systems Engineering", Nadim Mulaf and Kirt Williams, Artech House.
3. "Mechanics of Microelectromechanical systems", Nicolae Lobontiu and Ephrahim Garcia, Kluwer Academic Publication.
4. "Silicon Processing for the VLSI era Volume -1 Technology", Stanley Wolf and Richard Tauber, Lattice press.
5. "Smart Material Systems and MEMS: Design and Development Methodologies", Vijay K. Varadan, K.J.Vinoy and S. Gopalkrishnan, John Wiley and sons Ltd.
6. "Springer Handbook of Nanotechnology", Bhushan, Springer Inc.

B.E. (Mechanical and Automation) – Part II

6.PROJECT

Teaching Scheme
Practical: 5 Hrs / Week

Examination Scheme
Term work: 100 Marks
Oral/ P.O.E: 50 Marks

Project topic:

1. To provide an opportunity to students do work independently on a topic/ problem/experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the teachers.
2. To encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Project Load:

Maximum 9-10 students in one batch, involving 03 groups Maximum 9-10 students shall work under one Faculty Member Group of one student is not allowed under any circumstances.

Project Definition :

Project work shall be based on any of the following:

1. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
2. Experimental verification of principles used in Mechanical Engineering Applications.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.

Project Term Work: 100 Marks

The term work under project submitted by students shall include and assessment of
Term work should be as below

Marks :

1 Work Diary: 25 Marks

Work Diary maintained by group and countersigned by the guide weekly.
The contents of work diary shall reflect the efforts taken by project group for

1. Searching suitable project work
2. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring out the project.
3. Brief report of feasibility studies carried to implement the conclusion.
4. Rough Sketches/ Design Calculations, etc.

Project report format:

Project report should be of 60 to 70 pages. For standardization of the project reports the following format should be strictly followed.

1.Page size	: Trimmed A4
2. Top Margin	: 1.00 Inches
3. Bottom Margin	: 1.32 Inches
4. Left Margin	: 1.5 Inches
5. Right Margin	: 1.0 Inches
6. Para Text	: Font - Times New Roman; 12 point
7. Line Spacing	: 1.5 Lines
8. Page Numbers	: Right aligned and in footer.
9.Headings	: Font Times New Roman; 12 point New Times Roman, 14 point, Boldface
10. Certificate	:All students should attach standard format of Certificate as described by the Department. Certificate should be awarded to batch and not individual student Certificate

should have signatures of Guide, Principal, and External Examiner. Entire Report has to be documented as one chapter.

11 Index of Report :

i) Title Sheet
ii) Certificate
iii) Acknowledgement
iv)Table of Contents
v)Synopsis
vi) List of Figures
vii) List of Photographs/ Plates
viii)List of Tables

1. Introduction
2. Literature Survey/ Theory
3. Design/ Experimentation/ Fabrication/ Production/ Actual work carried out for the same.
4. Observation Results
5. Discussion on Results and Conclusion

12 References : References should have the following format
For Books:
"Title of Book"; Authors; Publisher; Edition;
For Papers:
"Title of Paper"; Authors; Conference Details; Year.

2.Presentation: 30 Marks on the Basis of Continuous assessment
A) For report : 15 Marks
B) The group has to make a presentation in front of the faculties of department **30 Marks.**

C) Oral 50 Marks.