SHIVAJI UNIVERSITY, KOLHAPUR

(Revised Structure to be implemented from July 2012)

M.E (Mechanical- Production Engg.) Semester – I

Sr. No	Name of the Subject	Teaching Scheme		Examination Scheme			Total Marks
		L	T/P	T/W	TP	Pr/Oral	
1	**Advanced Materials and Manufacturing Processes**	**3**	**-**	**-**	**100**	**-**	**100**
2	**Design of Experiments and Research Methodology**	**3**	**1**	**25**	**100**	**-**	**125**
3	**Metal Forming Technology**	**3**	**-**	**-**	**100**	**-**	**100**
4	**Elective-I**	**3**	**1**	**25**	**100**	**-**	**125**
5	**Elective-II**	**3**	**1**	**25**	**100**	**-**	**125**
6	**Measurements & Instrumentation Lab.**	**-**	**2**	**25**	**-**	**25**	**50**
7	**Advanced CNC Technology Lab.**	**-**	**2**	**25**	**-**	**25**	**50**
8	**Seminar-I**	**-**	**1**	**25**	**-**	**-**	**25**
	Total	**15**	**10**	**150**	**500**	**50**	**700**

L-Lecture, T/P- Tutorial/Practical, T/W-Term Work, TP-Theory Paper, Pr/Oral- Practical/Oral Examination

M.E. (Mechanical- Production Engg.) Semester - II

Sr. No	Name of the Subject	Teaching Scheme		Examination Scheme			Total Marks
		L	T/P	T/W	TP	Pr/Oral	
1	**Optimization Techniques**	**4**	**-**	**-**	**100**	**-**	**100**
2	**Advanced Casting Technology**	**3**	**1**	**25**	**100**	**-**	**125**
3	**Production and Operations Management**	**3**	**1**	**25**	**100**	**-**	**125**
4	**Elective-III**	**3**	**-**	**-**	**100**	**-**	**100**
5	**Elective-IV**	**3**	**1**	**25**	**100**	**-**	**125**
6	**Adv. Manufacturing Engg. Lab.**	**-**	**2**	**25**	**-**	**25**	**50**
7	**Automation & Simulation Lab.**	**-**	**2**	**25**	**-**	**25**	**50**
8	**Seminar-II**	**-**	**1**	**25**	**-**	**-**	**25**
9	**Comprehensive Viva Voce#**	**-**	**-**	**-**	**-**	**50**	**50**
	Total	**15**	**10**	**150**	**500**	**100**	**750**

L-Lecture, T/P- Tutorial/Practical, T/W-Term Work, TP-Theory Paper, Pr/Oral- Practical/Oral Examination

List of Elective Subjects

Elective I

1. Facility Planning & Plant Layout
2. Advanced Machine Tool Design
3. Mechatronic System Design
4. Advanced Tooling & Die Design
5. Human Resource Management
6. Costing & Cost Control

Elective II

1. Advanced Fluid Power Engg.
2. Manufacturing System Design
3. MEMS & Nanotechnology
4. Supply Chain Management & Logistics
5. Engineering Economics
6. Financial Management

Elective III

1. Fabrication Engg. & Welding Technology
2. Entrepreneurship Development
3. Precision Manufacturing
4. Reliability Engineering
5. World Class Manufacturing
6. Total Quality Management

Elective IV

1. Plastics Processing & Die Design
2. Automatic Control Engineering
3. Enterprize Resource Planning
4. Industrial Automation and Robotics
5. Project Management
6. **Open Elective *** (Please see note.)

M.E. (Mechanical- Production Engg.) Semester – III

Sr. No	Name of the Subject	Teaching Scheme		Examination Scheme			Total Marks
		L	T/P	T/W	TP	Pr/Oral	
1	**Seminar-III**	**-**	**1**	**25**	**-**	**25**	**50**
2	**Dissertation Phase –I**	**-**	**4**	**50**	**-**	**50**	**100**
	Total	**-**	**5**	**75**	**-**	**75**	**150**

L-Lecture, T/P- Tutorial/Practical, T/W-Term Work, TP-Theory Paper, Pr/Oral- Practical/Oral Examination

M.E. (Mechanical- Production Engg.) Semester - IV

Sr. No	Name of the Subject	Teaching Scheme		Examination Scheme			Total Marks
		L	T/P	T/W	TP	Pr/Oral	
1	**Dissertation Phase –II**	**-**	**6**	**200**	**-**	**100**	**300**
	Total	**-**	**6**	**200**	**-**	**100**	**300**

(**Grand Total 1900)**

L-Lecture, T/P- Tutorial/Practical, T/W-Term Work, TP-Theory Paper, Pr/Oral- Practical/Oral Examination

Notes - 1. *** Open Elective**: The students can choose under **Open Elective,** any subject from any of the University approved M.E./M.Tech. programs being run at the institute where this M.E. (Mech.-Prod. Engg.) is being run.

2. # **Comprehensive Viva Voce**: A comprehensive oral examination will be conducted based on the total curriculum of Semester I and Semester II.

Note for Teaching Workload Purpose: Seminar I, II, III – One hour per student per week
Dissertation Phase I – Two hours per student per week
Dissertation Phase II – Three hours per student per week

EQUIVALENCE OF SUBJECT HEADS

Sr. No.	Pre-Revised Subject	Equivalent Subject in revised syllabus	Remarks
1	Sem.-I, Industrial Instrumentation & Control	E-IV, Automatic Control Engineering	
2	Sem.-I, Advanced Manufacturing Techniques-I	Sem.-I, Metal Forming Technology	
3	Sem.-I, Production Management	Sem.-II, Production and Operations Management	
4	Sem.-I, Design of Experiments and Research Methodology	Sem.-I, Design of Experiments and Research Methodology	
5	Sem.-I, E-I, Advanced Production Systems	Sem.-II, E-III, World Class Manufacturing	
6	Sem.-I, E-I, Facility Planning & Material Handling	Sem.-I, E-I, Facility Planning & Plant Layout	
7	Sem.-I, E-I, Industrial Hydraulics & Pneumatics	Sem.-I, E-II, Advanced Fluid Power Engg.	
8	Sem.-I, E-I, Costing & Cost Control	Sem.-I, E-I, Costing & Cost Control	
9	Sem.-I, E-I, Fabrication Engg. & Welding Technology	Sem.-II E-III Fabrication Engg. & Welding Technology	
10	Sem.-II, Advanced Manufacturing Techniques-II	Sem.-II, Advanced Casting Technology	
11	Sem.-II, Quantitative Techniques	Sem.-I, Optimization Techniques	
12	Sem.-II, Human Resource Development	Sem.-I, E-I, Human Resource Management	
13	Sem.-II, Machine Tool Design	Sem. I, Ele. I, Advanced Machine Tool Design	
14	Sem.-II, E-II, Total Quality Management	Sem. I, E-I Quality Management	
15	Sem.-II, E-II, Non-metallic Manufacturing Techniques	Sem. IAdvanced Materials and Manufacturing Processes	
16	Sem.-II, E-II, Materials & Finance Management	Sem.-I, E-II, Financial Management	
17	Sem.-II, E-II, Mechatronics	Sem.-I, E-I, Mechatronic System Design	
18	Sem.-II, E-II, Manufacturing System Design & Analysis	Sem.-I, E-II, Manufacturing System Design	

M.E. (Mechanical -Production Engg.) Semester– I (Revised)

1. ADVANCED MATERIALS & MANUFACTURING PROCESSES

Teaching Scheme:
Lectures 3 Hrs/ week

Examination Scheme
Theory: 100 marks

Objective:

1. To familiarize the students with latest developments in material science and materials to cope up with requirements of industry.
2. To familiarize the students with developments in non conventional manufacturing Processes

SECTION I

1. **Review of Engineering Materials**- metals, alloys- ferrous and non-ferrous, plastics and polymers, ceramics and composites. Dual phase steels, micro alloyed steels, High strength low alloy steels, transformation inducted plasticity (TRIP) steels, Maraging steels. Heat treatment of ferrous and non ferrous alloys for modification of structure and properties. **(3)**
2. **Modern materials**- Compositions, properties and applications of: Inter-metallics, Ni and Ti aluminides, smart materials, shape memory alloys, Metallic glass- quassi crystals, Dielectrics, semi conductors, conductors & super conducting materials. Magnetic and photoelectric materials, optical materials, Bio materials, micro electronic materials and nano materials. **(4)**
3. **Non Metallic Materials**- Polymer materials, formation of polymer structures, production techniques of fibers, foams, adhesives and coatings. Structure, properties and applications of engineering polymers. Advanced structural ceramics, WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN and diamond- properties, processing and applications. **(4)**
4. **Composites**: **Fibers**-glass, boron, carbon, organic, ceramic and metallic fibers- **Matrix materials**- polymers, metals and ceramics. Processing of polymer matrix composites: open mould process, bag molding, compression molding with BMC and SM- filament winding, pultrussion- centrifugal casting, injection molding, applications of PMC's. Processing of metal matrix polymers: solid state fabrication techniques- diffusion bonding, powder metallurgy techniques, plasma spray, chemical and physical vapor deposition of matrix on fibers, Liquid state fabrication methods, Infiltration, squeeze casting, Rheo casting, compo casting. Applications **(6)**
5. **Selection of Materials:** Motivation for selection, cost basis and service requirements- selection for mechanical properties, strength, toughness, fatigue and creep. Selection for surface durability, corrosion and wear resistance. Relationship between materials selection and processing. Case studies in material selection with reference to aero, automobile, marine, machinery and nuclear applications. **(3)**

SECTION II

6. **Classification and Types of Conventional Manufacturing Processes**- forging, rolling, extrusion, wire drawing, sheet metal processes. Manufacturing automation,

Nontraditional manufacturing processes. Economics of nontraditional and automated manufacturing. Introduction to micromachining and MEMS. Introduction to coatings and tribology **(4)**

7. **Rapid Prototyping:** Product development cycle & importance of prototyping. Types of prototypes, principles and advantages and different types of generative manufacturing processes, viz. stereolithography, FDM, SLS etc. Factors concerning to RP: consideration for adaptations, advantages, accuracy, economic considerations. **(4)**
8. **Non Conventional Machining Processes**: Introduction and ned for non- conventional machining processes, Principle and theory of material removal. Process parameters, advantages, limitations and applications of ultrasonic machining, laser beam machining and electrochemical machining **(4)**
9. **Special Processes and Electronic Fabrication:** Principles, salient features, advantages and applications of abrasive floor machining, magnetic abrasive finishing, wire EDM, electrochemical grinding, honing, lapping and super finishing.
   Principles, elements, process, advantages, applications and surface preparation etc. of physical vapor deposition, chemical vapor deposition, electro less coating and thermal metal spraying. **(5)**

Reference Books:

1) "HMT Handbook" – Production Technology (TMH)
2) Willer, "Non- traditional Machining Processes", SME publications.
3) G.F.Benidict, "Advanced Manufacturing Processes", Marcel Dekker Publisher
4) E. Paul DeGarmo, J. T. Black & Ronald A. Kohser, "Materials & Processes in Manufacturing", (PHI)
5) Geoff Eckold "Design & Manufacturing of Composite Structures", (Jaico Publishing House)
6) S. Kalpaljian & Steven R. Schmidt, (Pearson Education) "Manufacturing Processe for Engineering Materials",
7) Krishnan K.Chawla, "Composite Material Science and Engineering", Springer- Verlag, 1987
8) Agarwal D & Brontman L.J., "Analysis & Performance of Fibre Composites", John Willey Publications, 1990
9) Mallik P.K. & Newman S.,"Composite Materials Technology", Henser Publications, 1990
10) Charles J A, Crane F.A.A. & Furness J A G ,"Selection and use of Engineering Materials", (3/e), Butterworth – Heiremann – 1977
11) "Materials and their applications", (4/e)- Jaico- 1999
12) "Non Conventional Machining", – P.K.Mishra (IIT, Kharagpur), Narosa Publishing House
13) "Manufacturing Science" - A. Ghosh and Malik – Affiliated East West Press Pvt. Ltd.
14) " Physical Metallurgy" – Vijendra Singh (Standard Publishers Distributors, New Delhi)

15) "Materials Handbook", (15/e) - Brady, George S.; Clauser, Henry R. & Vaccari, John A., McGraw Hill Handbooks.

M.E. (Mechanical -Production Engg.) Semester– I (Revised)

2. DESIGN OF EXPERIMENTS & RESEARCH METHODOLOGY

Teaching Scheme:	**Examination Scheme**
Lectures 3 Hrs/ week	Theory: 100 marks
Practical: 1 Hrs/ Week	Term work: 25 marks

1. **Introduction**: Meaning and objectives of research, Types of research, Research approaches, Research process, Research problem, Selection of research problem, Defining research problem, Literature review, Meta-analysis, Effect sizes, Integrating research findings, Identification of research gaps, Errors in research
2. **Research Design**: Meaning, need, and features of good design, Dependent, independent, and extraneous variables, Experimental and control groups, Treatments, Experiment, Research designs in exploratory studies, Research designs in descriptive studies, Experimental research designs (informal and formal), Replication, Randomization, Blocking
3. **Sampling**: Need for sampling, Population, Sample, Normal distribution, Steps in sampling, External validity and threats, Sampling error, Probability sampling, Random sampling, Systematic sampling, Stratified sampling, Cluster sampling, Student's t-distribution, Standard error, Determination of sample size
4. **Measurement Techniques**: Measurement scales, Errors in measurement, Content validity, Criterion-related validity, Construct validity (convergent and discriminant), Reliability, Rating scales, Paired comparison, Differential scales, Summated scales, Cumulative scales, Factor scales
5. **Data Collection and Analysis**: Primary data collection through observations and interviews, Questionnaire surveys, Secondary data collection, Data processing, Measures of central tendency and dispersion, mean, median, mode, range, variance, standard deviation, inter-quartile range, histogram, box-plot, normal probability plot, Measures of association (simple regression analysis, association of attributes)
6. **Hypothesis Testing**: Null and alternative hypothesis, Level of significance, Type I and type II error, Two-tailed and one-tailed tests, Procedure of hypothesis testing, Power of hypothesis test, Hypothesis testing of means, Hypothesis testing of mean difference
7. **Analysis of Variance**: Introduction, One-way ANOVA, Two-way ANOVA, Preparation of ANOVA Table and calculation of F-ratio
8. **Report Writing**: Interpretation of results, Techniques and precaution in interpretation, Steps in report writing, Layout of research report, Types of research report, Mechanics and precautions in writing research report, Structure of research paper, Referencing and bibliographic styles, Citations, Impact factor, Peer review, Plagiarism

Term Work:

1. Six assignments based on above syllabus, including quantitative assignments on data analysis, hypothesis testing, and analysis of variance using software packages like SYSTAT, MINITAB, SPSS and MATLAB.
2. Each candidate will identify major and minor research area of interest, related to the field of manufacturing/industrial engineering, and will collect and review at least 10 journal papers in the identified major and minor interest areas. The findings of review will be submitted as part of term-work.

Reference Books:

1. Montgomery, Douglas C. (2007) – Design & Analysis of Experiments, 5/e. (New Delhi,
Wiley Student Edition, Wiley India Pvt. Ltd.) ISBN: 978-81-265-1048-1
2. Montgomery, Douglas C. & Runger, George C. (2007) – Applied Statistics & Probability
for Engineers, 3/e, . (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.), ISBN: 978-81-
265-1424-3
3. Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN: 81-317-0496-3
4. Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN: 81-7722-372-0
5. Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (New Age International, New Delhi)
6. Krishnaswamy, K. N., Sivakumar, Appa Iyer and Mathirajan, M. (2006), Management Research Methodology: Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
7. Panneerselvam – Research Methodology, (PHI), ISBN: 81-203-2452-8

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3. METAL FORMING TECHNOLOGY

Teaching Scheme:
3 Lecture Hours per week

Examination Scheme:
Theory Paper (3 hours): 100 Marks

COURSE OBJECTIVE

1.To develop fundamental understanding in principles of various metalworking processes.
2. To develop an understanding of how these processes are carried out in industry.

1. **Introduction**: Study of various forming processes, their significance with respect to other manufacturing processes, Classification based on volume, stage, complexity; Requirements for near net shape manufacturing.
2. **Fundamentals**: Mechanics of metal working, stress strain relationship, yield criteria, Equilibrium in Cartesian, cylindrical and spherical coordinates, Slab method and lower and upper bond methods for load,

their significance in investigating and modeling of metal working operations; plastic work, work hardening, strain rate and temperature, deformation zone geometry, formability, forming limit diagrams.
3. **Workability**: Overview at the workability, workability in sheet metal forming, forging, rolling, and in extrusion and wire drawing. Friction and Lubrication in: Rolling, Drawing, Forging, Extrusion, Drawing of Wire.
4. **Forging**: Equipments: Hammers, Presses, interaction between forging process and equipment, Forging materials and practices or processes: Light alloys, titanium alloys and heat resistance alloys. Effect of forging variables on properties; Forging die design: Design principles, Preform design considerations, Die materials.
5. **Rolling**: Classification of Rolling Processes, Rolling mills, Hot- Rolling, Rolling of Bars and Shapes; Forces and Geometrical relationship in Rolling, Simplified analysis of rolling load: variables, problems and defects in rolled products, Rolling mill control, Theories of cold rolling, hot rolling, torque and power, Roll pass design
6. **Extrusion**: Classification of extrusion processes, extrusion equipment, hot extrusion, defects in extrusion, Analysis of the extrusion process, cold Extrusion and cold forming, hydrostatic extrusion, extrusion of tubing, Production of seamless pipe and tubing.
7. **Wire Drawing**: Introduction, wiredrawing, analysis of wiredrawing and Residual stress in wire, wire drawing dies.
8. **Sheet Metal Forming**: Introduction, forming methods, shearing and blanking, bending, stretch forming, deep drawing, forming limit criteria, Defects in formed parts.
9. **Latest Trends in Forming**: Isothermal forging, Near net shape manufacturing, thermo- mechanical treatments, High Energy Rate Forming (HERF), super plastic forming technology, hydro forming, Laser beam forming, fine blanking,

Note: Exposure to suitable software is recommended for modeling and analysis of processes.

Reference Books:
1. George E. Dieter - Mechanical Metallurgy, McGrew Hill, London, 1988
2. G. E. Dieter - Workability Testing Techniques, American Society for Metals, Metals Park, 1984
3. Metal Forming Handbook, -Schuler, Springer-Verlag Berlin Heidelberg New York, (2008) ISBN 3-540-61185-1
3. R. Sharan, S.N. Prasad - Forging Design and Practice
4. Forging Equipment, Material and Processes, J. Altan, F. W. Boulger - Metals Ceramic Information Center, Columbus 1973.
5. Roll Forming Handbook, - Geotge T. Halmos, (CRC Press, Taylor & Francis), (2006) ISBN 0-8247-9563-6
6. Metal Forming Fundamentals & Applications – Alan T, American Society of Metals, Metal Park 1983
7. Metal Forming Mechanics & Metallurgy, Hosford WF and Cadell R.M. , Prentice Hall, Englewood Cliffs, 1993
8. ASM Hand Book - Forming and Forging, 9/e, Volume 14, (1998)

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6. MEASUREMENTS & INSTRUMENTATION LABORATORY

Teaching Scheme:
Practical: 2 Hrs. per week

Examination Scheme:
Term work: 25 marks
Practical Exam.: 25 marks

The laboratory work shall consist of exercises as given below. (any seven).

1. Measurement of forces using strain gauges and study of static characteristics.
2. Measurement of temperature using minimum two types of temperature sensors and study of static characteristics
3. Pressure measurement using manometer, dead weight tester and Bourdon tube; Static calibration.
4. Flow measurement using rotameter/turbine flow meter,
5. Displacement, rotational speed and velocity measurement
6. Measurement of vibrations of machine tool members / structures
7. Static performance characteristics of operational amplifiers
8. Analog to Digital and Digital to Analog conversion of electrical signals
9. Use of Proportional/Integral/Derivative mode for measurement and control of speed/pressure/temperature

- Term work shall be assessed on the basis of completion of above experiments and submission of reports.
- Practical examination: Duration 3 hours – The candidate shall carry out the practical exercise (15 marks) on one of the above topics. It will be followed by an oral examination (10 marks).

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7. ADVANCED CNC LABORATORY

Teaching Scheme:
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Term work: 25 Marks
Practical Examination: 25 Marks

Course Objective

To expose the student to the Computer Aided Manufacturing practices followed in the industry.

The Term Work shall consist of following exercises.

1. Generating and simulating CNC part programs from the CAD models (at least two exercises each).

1.1) Preparing a suitable CAD model for a part to be turned and generating the CNC part program to machine the same on a CNC lathe from the given form of raw material using a suitable CAM software and a post processor.

1.2) Preparing a suitable CAD model for a part to be machined and generating the CNC part program to machine the same on a CNC machining center (vertical/horizontal) from the given form of raw material using a suitable CAM software and a post processor. (2 dimensional machining like drilling, tapping, reaming, boring, face/slot milling etc.)

1.3) Preparing a suitable CAD model for a part to be machined and generating the CNC part program to machine the same on a CNC machining center (vertical/horizontal) from the given form of raw material using a suitable CAM software and a post processor. (3 dimensional machining like simple cylindrical/rectangular cavities or pockets).

Note: A different exercise shall be given to each student in the batch.

2. Generating a simple part program using CAM software and executing it on a CNC machine (at least one exercise each) on CNC lathe and CNC machining center.

Note: A different exercise shall be given to each group of two students in the batch.

The journal shall consist of the printouts and report of the above exercises.

Practical Examination: (Duration 2 hours)
It shall consist of,

1) From a CAD model Generating and simulating a simple CNC part program (Lathe or Machining Center) using a CAM software by individual candidate (15 Marks)
2) Oral Examination based on the Term Work (10 Marks)

References: Use of Help Manuals of CAM software and CNC Machines manuals is recommended.

M. E. (Mechanical-Production Engg.) – Semester I (Revised)

8. SEMINAR – I

Teaching Scheme:	**Examination Scheme:**
Practical: 1 Hour/ Week	Term Work: 25 marks

Seminar - I should be based on the literature survey on any topic relevant to manufacturing engineering and management. It may be leading to selection of a suitable topic of dissertation.

Each student has to prepare a write-up of about 25 pages. The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department.

The student has to deliver a seminar talk in front of the faculty of the department and the students. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

M. E. (Mechanical-Production Engg.) – Semester I (Revised)

Elective I - 1. FACILITY PLANNING AND PLANT LAYOUT

Teaching scheme:
Lectures: 3 hrs/week,
Tutorial: 1 hrs/week

Examination scheme:
Theory paper (3 hours): 100 marks
Term Work: 25 marks

1. Introduction, nature, significance and scope of facility layout and design
2. Facility location: location analysis, single-facility and multi-facility location problems, location models, set covering problems, warehouse location problems, location allocation problems
3. Facility layout: definition, significance, objectives, steps in layout planning, quantitative techniques, computerized layout planning procedures, Space determination and area allocation
4. Group technology, Production Flow analysis, Rank Order Clustering, design of assembly and production lines, line balancing.
5. Material handling: definition, principles of material handling, unit load concept, Master flow pattern, material or product handling methods, processes General flow patterns, flow planning criteria. Design of a flow pattern. Techniques for analyzing materials flow, material handling system design, equipment types and selection, packaging requirements and containers selection, safety considerations
6. Bulk Material Handling: Bins, hoppers, feeders, belt, chain, screw, vibratory conveyers, pneumatic conveyors Bucket elevators, escalators.
7. Storage and warehousing: functions, objectives, and principles, facility services
8. Automatic storage and retrieval systems, design principles, equipment and control

Term work: Minimum six assignments based on the syllabus including modeling, analysis and simulation of facility layout and material handling systems, using suitable simulation software. Minimum one industrial case study is essential.

Reference Books:

1. Tompkins, J.A. and J.A.White, Facilities planning, John Wiley, 2003.
2. Richard Francis.L. and John A.White, Facilities Layout and location-an analytical approach, Prentice Hall India, 2002.
3. James Apple, Plant layout and Material Handling, John Wiley, 1977.
4. Panneerselvam,R, “Production and Operations Management”, Prentice Hall India, 2007

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Elective I - 2. ADVANCED MACHINE TOOL DESIGN

Teaching Scheme:
Lectures 3 Hrs/ week
Practical: 1 Hour / Week

Examination Scheme
Theory: 100 marks
Term work: 25 marks

1. Introduction: Classification of machine tools based on their construction, precision, control, drives and rate of production (General purpose machines, special purpose machines and CNC machine tools),
2. Kinematics of Machine Tool: - Classification of kinematic systems used for motions of various elements of machine tools.
3. Drive Systems: - Selection of cutting speeds, and speed range, method of speed regulation, stepped, step-less, mechanical, electrical, hydraulic methods of speed regulation and their comparison. Stepped drives of machine tools- Gear drives, Gear box design, graphical representation of gear box operation with ray diagram, structure diagram, deviation diagram. Drives for CNC machine tools- AC and DC servomotors, Stepper motors.
4. Analysis for Strength and Rigidity: Consideration used in design for strength and rigidity, Structural analysis of various elements of machine tools such as beds, frames, slides, tables and screws, Structural design of beds for lathes, milling and drilling machines
5. Dynamics of Machine Tools: Effects of vibration, determination of natural frequency of vibration of machine structures, sources of vibration, analysis of single degree of freedom chatter, Vibration analysis of machine tool structure by partial differential equations, finite element analysis (FEA) techniques, Testing of machine tools
6. Design of Spindles: Various types of spindles, spindles support, friction/anti-friction bearings, hydro and aerostatic bearings; friction and antifriction screws, friction and anti friction slide ways, design calculations of spindles- deflection of spindle, optimum spacing between spindle support.
7. Control systems:- Various controls introduced on machine tools and their importance, various systems such as mechanical, electrical, electronics, optical, pneumatic/hydraulic systems used for position control, their application in automation, various stages of automation, devices for CNC machines - feedback devices, controllers
8. Special Purpose Machines: Requirement analysis, design considerations, drives, transmission and controllers, Modular design of machine tools

Term Work:
1) Design of at least two elements of machine tool - analytical and using FEA
2) Design of one sub- assembly like gear box, feed box, with design report and assembly detail drawing.
3) Design of a special purpose machines for suitable application- calculations, layout preparation
4) Case study on selection of drives for CNC machines

Reference Books:
1. N.K Mehta, (2005), Machine Tool Design & Numerical Control- TMH.
2. Sen & Bhattacharya, (2005), Principles of Machine Tools, - New Central Book Agencies
3. Yoram Koren, (2005) Computer Control of Machine Tools, McGraw Hill.
4. Nagpal, G.R., (2003), Machine Tool Engineering, - Khanna Publications
5. S.K. Basu & D. K. Pal (2001), Design of Machine Tool Design, - Oxford IBH Publishing Co.
6. Machine Tool Design Handbook – CMTI, TMH
7. Machinery's Handbook, (24/e) Ed. Henry H. Ryfeel, Industrial Press Inc.
8. P. H. Joshi, (2007) Machine Tools Handbook: Design and Operation - McGraw Hill
9. Yoshimi Ito, (2008), Modular Design of Machine Tools, McGraw Hill

10. Dr. Geo Schlesinger, Testing machine Tools, The Machinery Publishing Co. Ltd., Industrial Press, London.

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Elective I - 3. MECHATRONIC SYSTEM DESIGN

Teaching Scheme:	**Examination Scheme**
Lectures 3 Hrs/ week	Theory: 100 marks
Practical: 1 Hour/ Week	Term work: 25 marks

Course Objective

To study components of mechatronic systems and their integration for various applications.

1. Introduction: Introduction to mechatronic system, evolution, scope and components of mechatronic systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronic design **(3)**

2. Actuators, Sensors and Transducers: Hydraulic, pneumatic and electrical actuators and their system modeling, performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fibre-optic sensors, selection of sensor, piezo-electric sensors. **(6)**

3. Hardware Components: Number systems in Mechatronics, binary logic, Karnaugh map minimization, transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering, operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation. **(6)**

4. Programmable Logic Controller: Review of logic gates, basic structure, features, input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control, data handling, data movement, data comparison, arithmetic operations, code conversion, analog input and output, applications for automation, diagnostics and condition monitoring. **(6)**

5. Microcontroller: Comparison between microprocessor and microcontroller, organization of microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, programming of 8051, interfacing input and output devices, interfacing D/A converters and A/D converters, Various applications for automation and control purpose. **(6)**

6. Real-Time Interfacing: Introduction, Elements of Data Acquisition and Control System, Overview of I/O Process, Installation of the I/O Card and Software, Installation of the application Software, Examples, Over framing. **(4)**

7. Advanced Applications in Mechatronics: Mechatronic control in automated manufacturing, Artificial Intelligence in mechatronics, Fuzzy Logic application in Mechatronics, Microsensors in Mechatronics, Case studies of Mechatronic systems. **(5)**

Term Work :

1. Minimum Three exercises on analog-digital trainer to study fundamentals of digital electronics including OPAMPs

2. Minimum three programs on PLC for system automation involving of interfacing of sensors and actuators,
3. One exercise on interfacing of sensors and actuators with microcontroller
4. At least two exercises on a total Mechatronic System Design for applications like packaging, loading/unloading, pick and place etc.

Reference Books:

1) Mechatronics, 3/e --- W. Bolton (Pearson Education)
2) Mechatronics -Dan Necsulescu (Pearson Education)
3) The 8051 Microcontroller: Architecture, Programming and Applications, 2/e—Kenneth J. Ayala (Penram International)
4) Mechatronics: Principles, Concepts and Applications - N.P.Mahalik (TMH)
5) Introduction to Mechatronics & Measurement Systems – David G. Alciatore & Michael B. Histand (TMH)
6) Process Control & Instrumentation Technology –Critis D. Johnson (Pearson Education)
7) Mechatronics System Design - Devdas Shetty, Richard A. Kolk (CENGAGE)
8) Computer Control of Manufacturing Systems - Yoram Koren (McGraw Hill)
9) Automated Manufacturing Systems: Sensors, Actuators - S. Brain Morriss (McGraw Hill)
10) Industrial Automation – David W. Pessen (John Wiley & Sons)
11) 99 Examples of Pneumatic Applications – FESTO Controls Pvt. Ltd. Bangalore.
12) Modular Pick and Place Device– FESTO Controls Pvt. Ltd. Bangalore.
13) Rationalization with Handling Technology– FESTO Controls Pvt. Ltd. Bangalore.
14) Rationalization with Small Workpiece Feeding- FESTO Controls Pvt. Ltd. Bangalore.
15) Sensors for Handling & Processing Technology- FESTO Controls Pvt. Ltd. Bangalore.
16) Sensors in Production Engg. - FESTO Controls Pvt. Ltd. Bangalore.
17) Handbook of Industrial Automation – Richard L. Shell & Ernest L. Hall (Marcel Decker Inc.)
18) Programmable Logic Controllers" Programming Methods and Applications (with CD Rom) – Jack R. Hackworth & Fredrick D. Hackworth,Jr.(Pearson Education)
19) Mechatronics – M. D. Singh & J.G. Joshi (Prentice Hall of India)

M. E. (Mechanical-Production Engg.) – Semester I (Revised)

Elective I – 4. ADVANCED TOOL & DIE DESIGN

Teaching Scheme:
Lectures 3 Hrs/ week
Practical: 1 Hour/ Week

Examination Scheme
Theory: 100 marks
Term work: 25 marks

Course Objective

To study principles of designing fixtures and dies for industrial applications.

SECTION – I

1. Introduction: Jigs and Fixtures, Flexible Fixturing, Materials for Tools, Fixture and Dies. **(2)**

2. Modular Fixture Systems: Development of modular fixtures, T- slot based and Dowel pin based Modular Fixture systems, Interactive Computer Aided Fixture Design (I-CAFD) Structure, Locating / clamping Model Analysis and classification, Fixture Component Selection, Fixture component Assembly Manipulation. **(8)**

3. Group Technology based Computer Aided Fixture Design: Fixture Design process analysis, Fixture Structure Analysis, Fixture Feature Analysis, Fixture Design Similarity Analysis, Representation of Fixturing Feature information, Automated Fixture configuration Design **(6)**

4. Geometric and Accuracy Analysis: Geometric constraint conditions, Assembly Analysis, 3D Fixture configurations, Locating Accuracy and Error analysis, clamp planning, Machining accuracy analysis. **(4)**

SECTION – II

5. Die Design for Deep Drawing and Stretch Drawing: design considerations, die materials, efforts of friction, wear and lubrication, Die handling, Die clamping, dies for hydro mechanical deep drawing. **(5)**

6. Die Design for Hydro Forming: Process Technology, Die design considerations, die layout, die clamping, lubricants. **(4)**

7. Extrusion Dies: Die Design for metal extrusion, die materials, die clamping, die handling, Dies for Solid Sections, Dies for hollow section. **(7)**

Term Work

1) Case Study of T- Slot based Modular Fixturing system.
2) Case Study of Dowel pin based Modular Fixturing system.
3) Computer Aided Fixture Design for Simple Component.
4) Die Design for stretch drawing operation for a component.
5) Extrusion die design for solid section.
6) Study of die clamping systems for various processes.

Reference Books

1) Rong, Yeming; "Computer Aided Fixture Design", Marcel Dekker, ISBN 0-8247-9961-5
2) Metal Forming Handbook – Schuler, Springer- Verlag Berlin.
3) Dies for Plastic Extrusion – M.V. Joshi – Mc Millan.
4) Tool Design – C. Donaldson, LeCain & Goold (TMH)
5) Tool Design – H.W. Pollack (Taraporwalla)
6) ASM Handbook – Forming – ASME
7) Handbook of Die Design, 2/e – Suchy, I (McGraw Hill), 2006.
8) Design of Jigs and Fixtures – Hoffman (Pearson)
9) An Introduction to Jig & Tool Design, M.H.A. Kempster, (ELBS)
10) Jigs and Fixture Design Manual, Henrikson (Industrial Press, NY)
11) Die Design Fundamentals, J. R. Paquin, R. E. Crowley, Industrial Press Inc.
12) Jigs & Fixtures; Design Manual – (2/e), P.H. Joshi, (TMH) (2003)
13) A.y. C. Nee, K. Whybrew & A. Senthilkumar, Advanced Fixture Design for FMS, Springer ISBN: 0879096357

M. E. (Mechanical-Production Engg.) – Semester I (Revised)

Elective I- 5. HUMAN RESOURCE MANAGEMENT

Teaching Scheme:	**Examination Scheme**
Lectures 3 Hrs/ week	Theory: 100 marks
Practical: 1 Hrs/ Week	Term work: 25 marks

1. **Overview of Human Resource Management**:- Evolution of Human Resource Management from commodity approach to systems approach. Activity of Human Management – Perspective and challenges.

2. **Role of Human resource Management**:- Human resources Management of work . Changing Environmental and Human resource Management Objectives and Importance of HRM to- day and tomorrow.

3. **Human Resource Planning**: Human resource planning on macro level, Human resource planning in India Challenges and Possible solutions, Human Resource Demand Forecasting Supply forecasting. Preparing actions plan

4. **Human resource planning at micro level**:- Job analyses,- uses of job analyses; Methods and process of job analyses, Job description and job specification, Examples and exercise.

5. **Procurement of Human Resource**: Recruitment – Meaning and Process Formulating recruitment Policy, Evaluation of Recruitment Sources Modern Techniques of Recruitment Sources – Internet Based , Placement Agencies

6. **Selection of Human Resource**: Meaning and Process, Selection Hurdles – Application Blank, Employment Test – Utility and Validity, Employment Interviews, Principles and Techniques, Medical Text, referenced Cheek Appointment – Terms and Conditions.

7. **Training for Development**: Concept of Training and Developing ,Steps in Training and Development, Training Process: Identification of Training Needs, Sources of Information, designing the Program, Methods of Training Uses, Advantages and Disadvantages, Evaluation of Training, Evaluation of Procedures.

8. **Performance Appraisal**: Definition, Objectives, Essential of Performance appraisals and problems of performance appraisal process of Performance appraisal – Self Assessment and importance, Methods of Performance Appraisal – Traditional and Modern Methods – Straight Ranking Method, Peared Comparison Method, Critical Incident Method, Behavioral Anchored Rating Scale.

Term Work : Six assignments based on above syllabus including at least two case studies.

Reference Books :

1. Managing Technical People – Humphrey –Pearson.
2. Management of Organizational Behavior Leading Human Resources – Hersey.
3. Strategic Human Resource Management – Greer.
4. Managing Human Resources – Gomez – Mejm.
5. A framework for Human Resource Management – Dessler.

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Elective I - 6. COSTING & COST CONTROL

Teaching Scheme:	**Examination Scheme**
Lectures 3 Hrs/ week	Theory: 100 marks
Practical: 1 Hrs/ Week	Term work: 25 marks

Course Objective

Study of various aspects of costing, estimation and control and its application in manufacturing industry.

SECTION – I

1. Introduction: (a) Concept of cost, cost unit, cost center, classification of cost, different costs for different purposes. (b) Definition of costing, cost-price-profit equation, desirable conditions for a costing system. **(2)**
2. Cost Estimating: Definition, purpose and functions of estimation, role of estimator, constituents of estimates, estimating procedures. **(2)**
3. Estimation of Weight and Material Cost: a) Process of breaking down product drawing in to simpler elements or shapes, estimating the volume, weight and cost b) Review of purchasing procedure, recording of stock and consumption of material by LIFO, FIFO, Weighted average method **(4)**
4.a) Estimation of fabrication cost : Constitutes, direct cost, indirect cost, Procedure of estimation of fabrication cost; **b) Estimation of foundry cost:** Constitutes, direct cost, indirect cost, Procedure of estimation foundry cost **c) Estimation of forging cost:** Constitutes, direct cost, indirect cost, Procedure of estimation of forging cost. **d) Estimation of machining cost:** Constituents, direct cost, indirect cost, Procedure of estimation of machining cost. **(6)**
5. Machine hour rate: definition, constituents, direct cost, indirect cost, steps for estimation of machine hour rate for conventional machines, CNC lathe and machining center **(4)**
6. Labour Cost – Direct and indirect labour, Workmen classification, Definition of wages, Methods of remuneration **(2)**

SECTION –II

7. Overheads: Elements of overheads, classification, general considerations for collection, analysis of overheads, different methods for allocation, apportionment, absorption of overheads, **(4)**

8. Cost Accounting Methods: Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity based costing **(6)**

9. Cost Control: Use of cost data for policymaking and routine operation, control techniques such as budgetary control, standard cost, variance analysis, marginal cost and break even analysis **(3)**

10. Cost Reduction Areas: Procedures and systems in product, methods and layouts, administrative and marketing, rejection analysis, cost of poor quality, value analysis and value engineering, Zero Base Budgeting **(6)**

Note: Numerical treatment on topics 3, 4, 5, 7, 8 and 9 is essential.

Term Work:

Note: Use of computers is essential.

1. Estimation of weight and material cost for an assembly of three to five components.
2. Valuation of inventory by LIFO, FIFO, Weighted average method
3. Estimation for machine hour rate for representative machines – one conventional machine and one CNC lathe or machining center
4. Case study on estimation of overheads for a manufacturing unit
5. Study of different methods for allocation, apportionment, absorption of overheads
6. Case study in any one industry using any of the method of costing.
7. Different examples illustrating cost control
8. Case studies of cost reduction (Min. 2)

Reference Books:

1. Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.)
2. Costing Simplified: Wheldom Series – Brown & Owier (ELBS)
3. Cost Accounting: B. Jawaharlal (TMH)
4. Cost Accounting: R.R. Gupta.
5. Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata)
6. Cost Accounting: Jain, Narang (Kalyani Publishers)
7. A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan)
8. Mechanical Estimation and Costing – TTTI, Chennai (TMH)
9. Theory & Problems of Management & Cost Accounting – M.Y. Khan, P. K. Jain (TMH)

M. E. (Mechanical-Production Engg.) – Semester I (Revised)

Elective II – 1. ADVANCED FLUID POWER ENGINEERING

Teaching Scheme:
Lectures 3 Hrs/ week
Practical: 1 Hrs/ Week

Examination Scheme:
Theory: 100 marks
Term work: 25 marks

1. Fluid Power Systems: Classification, general features, applications in various fields of engineering, ISO/JIC Symbols of hydraulic and pneumatic systems, composite symbols.
2. Hydraulic Fluids: Fluid Compressibility, Pascal's Law, Bernoulli's theorem, Temperature effects, Fluid viscosity, Hydraulic fluids and their properties, Selection of fluid.
3. Hydraulic System Elements: Types of hydraulic cylinders and their mountings, cylinder- force, velocity, acceleration, power and losses, cylinder loading through mechanical linkages, calculation of cylinder forces, Hydraulic motors and ratings, types of motors- torque, power and flow rates; hydrostatic transmission, Pump types and flow rates, power and efficiency, characteristics curves,
4. Control of Hydraulic Elements:
a) Electrical devices for hydraulic circuits: Solenoids – push and pull types - AC and DC types, limit and pressure switches, torque motors
b) Pressure control valve: direction control valves, pilot operated relief, pressure reducing, quick exhaust, sequence valves, compensated valves, flow control valves and priority valves and circuits for their applications
c) Direction Control Valves- Actuators for valves, two way - two position, four way - two position, four way - three position, open center, close center, tandem center, pilot operated direction control valves, check valves, intermittent feed control, deceleration, Design considerations for directional control valves
d) Calculation of piston velocity, thrust under static and dynamic operation and application, considerations of friction and inertia loads
5. Hydraulic Servo-controlled Circuits and Applications: Hydraulic servo-controlled systems - components, Servo-circuits – tracer circuit, electro-hydraulic servo-valves, proportional valves; position, velocity and force control with servo-valves, torque converters
6. Pneumatics: Compressed air generation and contamination control, Effect of compressibility, Actuator functioning- thrust, cylinder air consumption, cylinder speed and flow rate, types of actuators, cylinders - types, pneumatic muscles, Rotary- air motors-types, semi-rotary actuators, Pneumatic grippers- finger like and vacuum type- suction lift force.
7. Elements of Pneumatic System: Direction control valves- Actuation, two way, three way, four way, check and shuttle valves, flow control valves, pressure control valves, speed control, quick exhaust valves, solenoid, pilot operated valves, time delay valve, pressure sequence valve, pneumatic counter; Electro-pneumatics- Electrical devices like switches, relays, electronic sensors-reed switch, proximity switch, solenoid valves,
8. Pneumatic Circuits: Air pressure losses, Circuit design and displacement-step and –time diagram, Impulse operation, pneumatic motor circuit, sequencing of motion, latching, time delay circuit and their applications, Pneumatic servo-system for linear and rotary motion, interfacing with programmable logic controller (PLC),
9. Fluidics: Logic gates, moving part logic (MPL) controls, MPL control of fluid power circuits

Term Work:
1) At least two experiments on hydraulic trainer to build and test circuits for machine tools or similar applications involving sequencing, reciprocating, counterbalance, synchronization, 2-handed safety, intermittent feed control and deceleration.
2) At least two experiments on Electro-Pneumatic trainer to build and test circuits for handling automation application involving gripping, reciprocation, sequencing, 2-handed safety, box sorting
3) Design of Hydraulic/Pneumatic system and related components for any one of the following
a) Broaching machine b) Hydraulic press c) Pneumatic press,

4) One experiment on circuit building and testing of hydraulic servo-system or Simulation and performance testing of a hydraulic/pneumatic circuit using suitable simulation software.

5) Industrial visits for studying applications of pneumatic and hydraulic system for automation and its report.

Reference Books:

1. Majumdar S.R., (2004), Oil Hydraulic Systems – Principles and Maintenance, TMH
2. John Pippenger and Tyler Hicks, Industrial Hydraulics, McGraw Hill
3. H. L. Stewart- Hydraulics and Pneumatics-Industrial Press
4. A. Esposito- (2006), 6/e, Fluid Power with Applications- Pearson Education
5. Vicker Sperry, - Industrial Hydraulics Manual
6. S.R.Mujumdar, - Pneumatics System: Principles and Maintenance, TMH
7. Joji P. (2008), Pneumatic Controls – (Wiley India), (ISBN 978-81-265-1542-4)
8. Electropneumatics, Basic Level - G. Prede, D. Scholz, (FESTO Didactic), (2002),

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Elective II – 2. MANUFACTURING SYSTEM DESIGN

Teaching Scheme:	**Examination Scheme**
Lectures 3 Hrs/ week	Theory: 100 marks
Practical: 1 Hrs/ Week	Term work: 25 marks

1. **Fundamentals**: System concept and design, Hierarchical structure, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production- Jobbing/Intermittent/ Continuous; Mass Production- Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage
2. **Product / Process Planning and Design**: Product Life Cycle, Planning of a new product, Product Design Aspects, Design cost considerations, Concurrent Engineering; Process and Operation Design- Computer Aided Process Planning, Optimum routing analysis using Dynamic Programming and Network Techniques, Criteria for line balancing.
3. **Manufacturing Optimization**: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system- Scope, basic mathematical models; Cost Estimating- Classical metal cutting cost analysis, Industrial cost estimation practices, Estimating material, setup and cycle times.

4. **Information Systems in Manufacturing**: Database structures, hierarchical, network, Relational- concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.
5. **Computer Simulation in Manufacturing System Analysis**: Characteristics, Models, applications of probability and statistics; Design and evaluation methodology, General framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.
6. **Modern approaches in Manufacturing**: Cellular Manufacturing- Group Technology, Composite part, Rank Order Clustering Technique, Hollier method for GT cell layouts; Flexible Manufacturing- Concept, components, architecture; Lean Production concept, principles, Agile Manufacturing- concept, principles and considerations for achieving agility.

Term Work:

Any six assignments out of the following:

1. Case Study of a manufacturing system in a small / medium organization.
2. Exercise on Concurrent Engg., Optimum routing analysis, Line Balancing
3. Exercise on Optimization of Single stage / Multi stage manufacturing system
4. Cost estimation of manufacturing a medium complex component of an assembly.
5. Creation of a relational database for a module of a manufacturing system, use of a suitable query language and generation of reports
6. Exercise on designing and analysis of GT Cell layouts
7. Simulation and performance testing of a manufacturing system

Reference Books:

1. Katsudo Hitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
2. B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X
3. Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9
4. Radhakrishan P., Subramaniyan S. and Raju V., "CAD / CAM / CIM", (3/E), New Age International Publication
5. Luca G. Sartori,(1998), " Manufacturing Information Systems", Addison Wesley Publishing Co.
6. N. Viswanadhan & Y, Narhari, (1998), "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India
7. Phillip F. Ostwald, Jairo Munez, (2002), " Manufacturing Processes and Systems", John Wiley & Sons (Students' Edition), ISBN 9971-512-34-3
8. Sanjay B. Joshi, Jeffrey S. Smith ,(1994), "Computer Control of Flexible Manufacturing Systems: Research and Development", Springer, ISBN 0412562006, 9780412562006
9. Manufacturing Systems Control Design: A Matrix-based Approach- Bogdan S., Lewis, S., Kovacic, Z., Mireles J.; Springer (2011), ISBN: 9788184898903

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ELECTIVE II – 3. MEMS & NANOTECHNOLOGY

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs / Week	Theory Paper: 100 marks
Practical: 1 Hr. / week	Term Work: 25 marks

Course Objective:

To understand the concepts and context of MEMS and nanotechnology.

1. Introduction: Micro-Electro-Mechanical Systems (MEMS), Microsystems and their products, miniaturization, applications, mechanical MEMS, thermal MEMS, micro-opto electro-mechanical systems, magnetic MEMS, radio frequency (RF) MEMS, micro fluidic systems, bio and chemo devices, Nanotechnology – definition, nanoscale, consequences of the nanoscale for technology and society, need and applications of nano electromechanical systems (NEMS) **(4)**

2. Micro Fabrication Processes & Materials: Materials for MEMS – substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials; **Fabrication Processes** – Bulk micromanufacturing, photolithography, photoresists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition – spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Doping – diffusion, ion implantation; Etching – wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; Wafer bonding – glass-frit, anodic and fusion bonding; LIGA process and applications. **(8)**

3. Microsensors and actuators: Sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – thermopiles, thermistors, micromachined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements – capacitance, piezomechanics, Piezoactuators as grippers, microgrippers, micromotors, microvalves, micropumps, microaccelerometers, microfluidics, shape memory alloy based optical switch, thermally activated MEMS relay, microspring thermal actuator, data storage cantilever. **(6)**

4. Microsystem Design: Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, electromechanical system and packaging. **(4)**

5. Nanomaterials: Molecular building blocks to nanostructures – fullerenes, nanoscaled biomolecules, chemical synthesis of artificial nanostructures, molecular switches and logic gates, nanocomposites; Carbon nanotubes - structure, single walled, multi walled, properties of carbon nanostructures and their synthesis, Potential applications of nano-structures. **(8)**

6. Nanofinishing Techniques: Abrasive flow machining, magnetic abrasive finishing, magnetorheological finishing, elastic emission machining, ion beam machining, chemical mechanical polishing, Nanomanipulation, Nanolithography, Top-down versus bottom –up assembly, Visualisation, manipulation and characterization at the nanoscale; Applications - in Energy, Tribology, Informatics, medicine, etc. **(8)**

Term Work:

It shall consist of six exercises based on the syllabus.

Reference Books:

1. Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin Heidelberg New York, ISBN 3-540-01218-4
2. Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X
3. Mahalik, N. P., (2007), MEMS, TMH, ISBN: 0-07-063445-9
4. Mahalik, N.P. (Ed.) (2006), Micromanufacturing & Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi)
5. Nanosystems: Molecular Machinery, Manufacturing & Computation, K E Drexler, (Wiley), (1992), ISBN 0471575186
6. P.Rai- Choudhury, Handbook of Microlithography, Micromachining & Microfabrication, SPIE,1997.
7. David Ferry, Transports in Nanostructures, Cambridge University Press, 2000.
8. Poole, Charles & Owen, Frank J., - Introduction to Nanotechnology, Wiley (India) Pvt. Ltd. ISBN: 978-81-265-10993
9. Various Internet resources: www.nanotechweb.org, www.nano.gov, www.nanotec.org.uk

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ELECTIVE II – 4. SUPPLY CHAIN MANAGEMENT & LOGISTICS

Teaching Scheme:
Lectures: 3 Hrs / Week
Practical: 1 Hr. / week

Examination Scheme:
Theory Paper: 100 marks
Term Work: 25 marks

1. **Introduction** and overview of supply chain management, inbound and outbound logistics, supply chain as a source of competitive advantage. Definition of logistics and SCM, evolution, scope, importance and decision phases – drivers of sc performance and obstacles.
2. **Supply Chain Network Design**: distribution in supply chain – factors in distribution network design –design options-network design in supply chain – framework for network decisions - managing cycle inventory and safety.
3. **Sourcing and Pricing in Supply Chain**: supplier selection and contracts - design collaboration - procurement process. Revenue management in supply chain
4. **Strategic Considerations for Supply Chain**: porter's industry analysis and value-chain models, the concept of total cost of ownership, supply stream strategies, classification and development guidelines, measuring effectiveness of supply management, logistics engineering.
5. **Operations Research Models** for operational and strategic issues in supply chain management. The bullwhip effect and supply-chain management game. Coordination and technology in supply chain, effect of lack of co-ordination and obstacles – Information

Technology and SCM - supply chain-IT framework. E-business and SCM. Metrics for supply chain performance

6. **Logistics Management**: Definition of logistics and the concepts of logistics. Logistics Activities: Functions of the logistics system – facility location, transportation, warehousing, order processing, information handling and procurement, Logistics environment, Logistics information systems, Logistics audit and control
7. **Inbound Logistics**: Buyer-Vendor co-ordination, Procurement, Vendor development, reduced sourcing and supplier partnership - benefits, risks and critical success factors, multi-level supply control.
8. **Distribution Management**: Outbound logistics, Facility location, Classical location problems, Strategic planning models for location analysis, location models, multi objective analysis of location models.
9. **Transportation** alternatives and technologies; transportation performance analysis; total transportation cost analysis; fleet development and management; fleet performance indicators; routing and scheduling; shipment planning; vehicle loading; transportation management and information systems requirements.
10. **Logistics in the Design and Development Phase:** Design Process, Related Design Discipline, Supplier Design Activities, Design Integration and Reviews, Test and Evaluation.
    Logistics in the Production Phase: - Production Requirements, Industrial Engineering and Operations Analysis, Quality Control, Production Operation, Transition from Production to user operation.
11. **Logistic in the Utilization and Support Phase**: - System / Product Support, TPM, Data Collection, Analysis and System Evaluation, Evaluation of Logistic Support Elements, System Modification.

Term work: Six assignments based on syllabus including case studies

Reference Books:

1. David Bloomberg, Stephen LeMay, Joe Hanna, (2002): Logistics, Prentice Hall,
2. Thomas Teufel, Jurgen Rohricht, Peter Willems: SAP Processes: Logistics, Addison-Wesley, 2002.
3. Julien Bramel, David Simchi-Levi. (2006), The logic of logistics: theory, algorithms, and applications for logistics management, Springer,
4. Murphy, G.J. "Transport and Distribution", 2/e, Business Books
5. Ballou, R.H., Business Logistics Management/Supply Chain, 5/e, 2004, Prentice-Hall
6. Martin Christopher, Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service.2/e, Pearson Education Asia
7. Sunil Chopra, Peter Meindl and D.V. Kalara, (2007), Supply Chain Management, Strategy, Planning, and operation, 3/e , Pearson Education
8. Benjamin S. Blanchard, (2009), Logistics Engineering & Management, 6/e, Prentice Hall of India
9. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition
10. Modeling the supply chain, Jeremy F.Shapiro, Thomson Duxbury, 2002
11. Handbook of Supply chain management, James B.Ayers, St.Lucle Press, 2000

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ELECTIVE II – 5. ENGINEERING ECONOMICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs / Week	Theory Paper: 100 marks
Practical: 1 Hr. / week	Term Work: 25 marks

1. **Definition of Economics** – various definitions, Nature of Economic problem, Production possibility curve Economic laws and their nature. Relation between Science, Engineering, Technology and Economics.
Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility – its practical application and importance.
2. **Meaning of Demand:** Individual and Market demand schedule, Law of demand, shape of demand curve, Elasticity of demand, measurement of elasticity of demand, factors effecting elasticity of demand, practical importance & applications of the concept of elasticity of demand.
3. **Meaning of production and factors of production:** Law of variable proportions, Returns to scale, Internal and External economics and diseconomies of scale.
4. **Various concepts of cost** – Fixed cost, variable cost, average cost, marginal cost, money cost, real cost opportunity cost. Shape of average cost, marginal cost, total cost etc. in short run and long run.
5. **Meaning of Market**: Types of Market – Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets)
6. **Supply and Law of Supply:** Role of Demand & Supply in Price Determination and effect of changes in demand and supply on prices.
7. **Nature and characteristics of Indian Economy**: (brief and elementary introduction), Privatization – meaning, merits and demerits. Globalisation of Indian economy – merits and demerits. Elementary Concepts of VAT, WTO, GATT & TRIPS agreement.

Term work: Minimum SIX assignments based on above syllabus. (Case studies desirable)

REFERENCE BOOKS:

1. Principles of Economics: P.N. Chopra (Kalyani Publishers).
2. Modern Economic Theory – K.K. Dewett (S.Chand)
1. A Text Book of Economic Theory Stonier and Hague (Longman's Landon)
2. Micro Economic Theory – M.L. Jhingan (S.Chand)
3. Micro Economic Theory – H.L. Ahuja (S.Chand)
4. Modern Micro Economics : S.K. Mishra (Pragati Publications)
5. Economic Theory – A.B.N. Kulkarni & A.B. Kalkundrikar (R.Chand & Co.)
6. Indian Economy: Rudar Dutt & K.P.M. Sundhram

M.E. (Mechanical-Production Engg.) Semester-I (Revised)

Elective II – 6. FINANCIAL MANAGEMENT

Teaching Scheme:
Lectures: 3 Hrs / Week
Practical: 1 Hr. / week

Examination Scheme:
Theory Paper: 100 marks
Term Work: 25 marks

Course Objective

To study the basic concepts of financial management applied to industry.

SECTION – I

1. Finance Function: - Objectives of Financial management finance function, the ROI concept of financial management and control **(4)**

2. Analysis and Interpretation of financial statement: - Using Ratio Analysis, cost volume profit analysis, capital budgeting – Nature and significance, Techniques of capital budgeting **(8)**

3. Financing decisions: - Planning capital structure, Debt – Equity Ratio and financing, cost of capital, concept of operating and financial leverage, Working capital management **(6)**

4. Sources of Finance: - Internal and External, Short, medium, and long term finance **(2)**

SECTION - II

5. Project Planning: - Generation and screening of project ideas market and demand analysis, technical analysis financial estimates and projection. **(4)**

6. Marketing of Securities: - Underwriting, role of stock exchange functions, operations, government regulations of stock exchanges in India. **(4)**

7. Management of Profits: - Appropriation of profits, Dividend policies determinants of dividend policies Issue of bonus shares, Right issue. **(4)**

8. Budgeting & Budgetary control: classification, flexible budget, cash budget, sales budget **(8)**

Term Work:

Minimum Six assignments based on above syllabus including analysis of financial data from industrial organizations. (Use of published financial statements of companies for analysis purpose is desirable.)

Reference Books:

1. Financial Management- I.M Pandey. Vikas Publishing House Pvt Ltd.
2. Management Accounting & Financial Management – R.K.Sharma & Shashi K. Gupta –Kalyani Publishers.
3. Project Planning, Analysis, Selection, Implementation & Review. - Prasanna Chandra- Tata Mac Grew Hill Publishers.
4. Financial Management- P.V. Konkani & B.G Sashay Prasad – Himalaya Publishing House.
5. Management Accounting- R S.N Pillai, Bagavathi – S.Chand & Company Ltd.
6. Corporate Finance – S. C. Kuchhal & Suchitra Mittal (Chaitanya Publication House)
7. Published financial statements of public/private limited companies.

1. OPTIMIZATION TECHNIQUES

Teaching Scheme:
Lectures 4 Hrs/ week

Examination Scheme
Theory: 100 marks

A. **Linear models**:
   1. **Linear programming-extensions**: Revised simplex method, Dual Simplex method, Bounded variables method, primal-dual relationships, duality theorems, economic interpretation of dual, dual of transportation model, sensitivity analysis in LPP and transportation models, Karmarkar's interior point algorithm
   2. **Dynamic programming**: formulation, recursive approach, Goal programming: formulation, graphical solution, algorithm
   3. **Integer programming**: Formulation, Cutting plane algorithm, Branch and bound algorithm

B. **Nonlinear models**:
   4. **Classical Optimization**: Single and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers, Kuhn-Tucker Conditions
   5. **Single-variable Optimization**: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method
   6. **Multi-variable Optimization**: Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method
   7. **Conjugate Direction Method**, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method
   8. **Introduction to Constrained Optimization**: Interior Penalty Function Method, Exterior Penalty function Method

Reference books

1. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill
2. Quantitative techniques in Management by N D Vohra, 4/e, TataMcGraw Hill
3. Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
4. Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers
5. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.

M.E. (Mechanical- Production Engg.) Semester-II (Revised)

2. ADVANCED CASTING TECHNOLOGY

Teaching Scheme:
3 Lecture Hours per week
1 Practical Hour per week

Examination Scheme:
Theory Paper (3 hours): 100 Marks
Term Work: 25 Marks

SECTION - I

1. Introduction: Comparison of casting technology with other metal processing technologies, merits and limitations, Comparison of casting manufacturing in India with that in other countries, specifications of composition and purity of cast metals.
2. Casting Design & Pattern / Die Making: Review of conventional method of casting and pattern design, pattern and die design considerations, Computer aided casting component design, Computer aided design and manufacturing of patterns and dies, advanced materials for patterns and dies - selection and applications, Use of simulation software for casting methoding and metal flow simulation, rapid pattern making
3. Resin Coated Sands & Processing: Properties of shell sand, no-bake sand systems, CO_2 sand, cold box sand, their comparison, equipment for sand processing, developments in sand mullers and sand plants, sand reclamation - cost and environmental issues, types of reclamation methods,
4. Sand Molding & Core Making Practices: High pressure molding technology, flaskless molding technology, magnetic molding, Core shooters used in shell core making and cold box process, Mold and core washes / coats – types, applications, selection and significance, Use of ceramic components and filters, their selection and significance.
5. Permanent Mold & Special Casting Techniques: Process parameters for Die casting- gravity, pressure and low pressure, Centrifugal casting, Vacuum casting, Investment casting, Squeeze casting; Advantages, limitations and applications.

SECTION II

6. Melting Practices: Developments in melting practices with reference to energy saving, scale of production, homogeneity of melt, handling and dispensing of molten metal, automated pouring equipment, use of robots for metal pouring, Furnaces- types and selection criteria, lining materials.
7. Melting technology: Melting technologies for steels, grey C.I., S.G. iron and compacted graphite iron, Al-Si alloys, Magnesium and Titanium based alloys; Inoculation, modification, de-oxidation, de-gassing, grain refinement treatments for various alloys, advanced methods for chemical analysis for metal compositions and temperature measurement.
8. Post processing of Castings: Fettling and shot basting techniques, salvaging of defective castings, heat treatment for ferrous and non-ferrous cast alloys, protective coating for castings.
9. Quality & Productivity: Casting defects and their classification, rejection analysis, remedial measures; instrumentation, mechanization and automation, Safety aspects in foundries, Environmental issues and regulations.
10. Management Information systems for Foundries: Techniques for improvement in productivity, Total Preventive Maintenance, Just-In-Time production, 'Five S' for foundries; Costing of castings, QS standards for foundries, Information systems for inland and global customer development.

Term Work:

1. Sand testing exercises for properties of raw sand, prepared sand such as strength, permeability and gas evaluation
2. Chemical analysis and microstructure study of cast alloys- Steels, Grey C.I., S.G.Iron, Al-Si alloys

3. Solid Modeling and optimization of casting methoding by use of suitable simulation software. –Minimum two components (One ferrous and one non-ferrous)
4. Industrial visits (minimum two) for studying molding, core making and melting technologies and submission of visit report.

Reference Books:

1) Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
2) Principles of Foundry Technology - P.L. Jain (TMH)
3) IIF - Foundry Journal
4) Advanced Pattern Making – Cox I.L. (The Technical Press, London.)
5) ASM Handbook – Vol. 15 Castings.
6) Metal Castings – Principles & Practice - T.V. Ramana Rao. (New Age International Pvt. Ltd. Publishers.)
7) AFS and Control hand book – AFS.
8) Mechanization of Foundry Shops – Machine Construction - P.N. Aeksenov (MIR)
9) Fundamentals of Metal Casting Technology - P.C. Mukherjee (Oxford, IBH)
10) Foundry Engineering – Taylor, Fleming & Wulff (John Wiley)
11) The Foseco Foundryman's Handbook, -Foseco, CBS Publishers & Distributors ISBN **:** 9780750619394
12) The New Metallurgy of Cast Metals Castings – Campbell, CBS Publishers & Distributors, ISBN- 9788131200919
13) Fundamentals of Metal Casting – Flinn, Addison Wesley
14)Principles of Metal Manufacturing Processes, J. Beddoes & M.J. Bibby (Elsevier, Butterworth, Heinemann) (2003)

M.E. (Mech.-Prod. Engg.) Semester– II (Revised)

3. PRODUCTION & OPERATIONS MANAGEMENT

Teaching Scheme:
Lectures 3 Hrs/ week
Practical: 1 Hrs/ Week

Examination Scheme
Theory: 100 marks
Term work: 25 marks

1. **Introduction**: Relation between production and operations and other functions, products and services, impact of information technology on productions and operations management, Business strategy- competitive priorities, developing operations strategy, productivity and competitiveness.
2. **Product and Service Design**: Traditional and concurrent product design, design for manufacture, service, assembly, Design of services, types of services, Quality of design, costs of quality
3. **Forecasting Models**: Classification, simple and weighted moving average method, exponential smoothening methods: additive model, trends and seasonality model, mixed model, Regression (linear and multiple) models, causal model, measures of forecasting accuracy, reliability of forecasts

4. **Aggregate Production Planning**: Production planning strategies, aggregate production planning model, chase demand and level workforce strategies, and techniques- trial and error, linear programming, transportation model, dynamic programming, Master production schedule, Materials requirement planning - structure and application; Capacity planning- measures and methods to generate capacity, Aggregate planning for services- yield management
5. **Operations Scheduling:** Approaches to scheduling – infinite and finite loading, forward or backward scheduling, Assignment model for assigning jobs to work centers, dispatching rules for scheduling n jobs on one machine, composite rules, scheduling with Johnson's rule – n jobs-2 stations with same and different sequence, 2 jobs-n stations (graphical method), preparation of Gantt's chart, job shop scheduling, open shop scheduling, dynamic scheduling in flexible manufacturing systems, employee scheduling for service
6. **Independent Demand Inventory Management**: Classification, EOQ models, order timing decisions, Safety Stock and reorder level decisions. Order quantity and reorder point, Continuous review systems, periodic review systems, selective inventory control - ABC analysis, Multi-item and Coordinated Replenishment Models- Spare parts and maintenance inventory models,
7. **Inventory models with probabilistic demands**: Single period discrete probabilistic demand model, multiple period probabilistic models
8. **Theory of constraints**: Optimized Production Technology, Drum-rope-buffer models, Constant-WIP (CONWIP) models, Planning and Control of JIT Systems

Note: Numerical treatment is expected on topic numbers 3, 4, 5, 6, 7.

Term Work:

1. Two assignments on demand forecasting of products using different models
2. One exercise on aggregate production planning and Master Production Schedule
3. One exercise on MRP System considering a small number of products (3-4) consisting of 4-5 components each and their manufacturing and ordering lead times
4. Exercises on various EOQ models
5. Exercises on probabilistic inventory models

Reference Books:

1. R. B. Khanna, (2007), Production & Operations Management, PHI
2. Martin K. Starr, (2007), Production & Operations Management, India Edition, Cengage Learning
3. Dr. K.C. Arora,(2009), Production & Operations Management, University Science Press (Laxmi Publications Pvt. Ltd.)
4. Edward S. Buffa & Rakesh K. Sarin, (2010), Modern Production / Operations Management, 8/e, Wiley India Pvt. Ltd.
5. Joseph S. Martinich, (2010), Production & Operations Management- An Applied Modern Approach, Wiley India Pvt. Ltd.
6. Everett E. Adam Jr, & Ronald J. Ebert, Production & Operations Management,
7. Jay Heizer, Barry Render & Jagdeesh Rajshekhar, (2009), Operations Management, 9/e, Pearson Education
8. Lee J. Krajewski & Larry P Ritzman, Operations Management- Strategy & Analysis, 6/e, Pearson Education.

9. Inventory management and Production Planning and Scheduling by E Silver, D Pyke and R Peterson, Wiley India
10. R Tersine, Principles of Inventory and Materials Management, Pearson Education
11. B. Mahadevan, (2007), Operations Management- Theory & Practice, Pearson Education
12. Panneerselvam R., (2006), Production & Operations Management, PHI
13. Silver, Pyke & Peterson, Inventory Management & Production Planning & Scheduling 3/e, John Wiley & Sons

M.E. (Mechanical-Production Engg.) Semester– II (Revised)

6. ADVANCED MANUFACTURING ENGINEERING LABORATORY

Teaching Scheme:	**Examination Scheme:**
Lectures 3 Hrs/ week	Theory: 100 marks
Practical: 1 Hrs/ Week	Term work: 25 marks

The laboratory work shall consist of exercises as given below

1. Two composite welding exercises consisting of at least three different parts each, welded together using TIG / MIG welding, Submerged arc welding and Spot welding. Design considerations for welding fixtures for the welded part to be prepared and submitted.
3. Making a simple part by using extrusion/wire drawing/stamping/blanking. Die design considerations to be studied and reported.
2. Machining of a workpiece by EDM process, study of preparation of the electrode and other parameters (**or** an actual case study in an industry)
4. Study of construction and operation of a coordinate measuring machine (CMM). Preparation of inspection report of a machined part for 4-5 dimensions on a CMM. **(Through an industrial visit)**
5. Design and drawing of a progressive die for a composite sheet metal part. Drawing may be done using a suitable Solid Modeling Software.

OR

5. Design and drawing of a fixture for a part to be machined on a CNC machining center. Drawing may be done using a suitable Solid Modeling Software.
6. Process planning for a fairly complex part to be machined on a CNC machining center/turn-mill center.

The journal shall include report of above exercises.

The oral examination shall be based on the term work carried out.

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7. AUTOMATION & SIMULATION LABORATORY

Teaching Scheme:	**Examination Scheme:**
2 Hrs. per week	Term work: 25 marks
2 Hrs. per week	Practical Exam: 25 marks

The laboratory work shall consist of exercises as given below

1) Design of hydraulic / pneumatic circuits for different machine tools, automation projects and their performance testing
2) Study, design / simulation of automation projects in material handling/packaging
3) Exercise on flexible automation using PLC, different sensors and actuators
4) Exercise on control of electrical motors using microcontroller / microprocessor.
5) Simulation of Robotic system for automation using a suitable software
6) Simulation of Electrohydraulic / Electropneumatic circuits using a suitable software -like FESTO PneuSim & HydroSim (Demo versions available on Internet) or Automation Studio or similar simulation software

- Term work shall be assessed on the basis of completion of above assignments and submission of reports.
- Practical examination: Duration 3 hours – The candidate shall carry out the practical exercise on one of the above topics (15 marks). It will be followed by an oral examination (10 marks).

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Elective III – 1. FABRICATION ENGINEERING & WELDING TECHNOLOGY

Teaching Scheme:	**Examination scheme**
Teaching: 3 Hours per week	Theory Exam: 100 Marks

1. **Preparatory Operations** – Different metal cutting methods used in fabrication, Advantages and limitations, straightening methods, bending on roll bending machine, press, press brake. Different edge preparation and cleaning methods, Precautions in preparatory operations for stainless steel and aluminum, fabrication characteristics of metals and composites.
2. **Fabrication Machinery** – Welding machines, three roll bending presses, press brakes, shearing machine, plasma arc cutting machine, Different types of hand grinders, loading, unloading equipments, material handling equipments.
3. **Welding Metallurgy**, controlling weld cracks, weld cracks, weld joint design, welding process selection, welded connections, welding fixtures, distortion control tools, solidification of weld, heat affected zone, automation in welding.
4. **Weld Quality and Defects**, failure of welds, inspection and testing of welds, I.S. code for welding and weldmets, destructive tests for welds, microstructure for weld joints, welding defects and remedies.
5. **Modern welding processes** like EBW, LBW, diffusion bonding, ultra sonic welding, pulsed current welding processes, friction welding. Welding of ceramics, plastics and composites.

6. **Stage inspection** in fabrication process, planning for fabrication jobs.

References Books:

1. Richard Little, "Welding and Welding Technology." TMH
2. U.S.Steel Corporation, "Fabrication of Stainless Steel."
3. ASTME, "Fundamentals of Tool Engineering Design", PHI Publication.
4. Schwartz M.M., "Metal Joining Manual", McGraw Hill, NY 1979.
5. Begman, "Manufacturing Processes"
6. Cnnur L.P., "Welding Handbook Vol I & II", American Welding Society, 1989.
7. Hauldcraft P.T, "Welding Process Technology", Cambridge University Press, 1985

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Elective III – 2. ENTREPRENEURSHIP DEVELOPMENT

Teaching Scheme:
Lectures: 3 Hrs. / Week

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks

Course Objective

To familiarize students with fundamentals of Entrepreneurship and to encourage them to Become successful entrepreneurs.

Section – I

1. Entrepreneurship: Definition of Entrepreneur and Entrepreneurship, entrepreneurial Process, Entrepreneurship and economic development, job creation, Indian scene. **(2)**

2. Small Scale Units: Concept and definition, role of S.S.I. in Indian economy, Government policies and facilities. **(3)**

3. Planning Small Scale Business: Business opportunity identification, idea generation, ideas from marketplace, market assessment, demand estimation. **(5)**

4. Government Support Organizations:
a) Central Government
b) State government
c) Financial support organizations
d) Government schemes and procedures **(5)**

5. Entrepreneurial Motivation: Self-disclosure, personality effectiveness, risk taking, Entrepreneurial competencies, case studies. **(4)**

Section – II

6. Business plan preparation: Meaning of business plan, project parameters, Information sources of economical and technical know how, selection of location, identification of raw material, suppliers, plants/machinery, process, manpower and other inputs such as power, water etc. **(4)**

7. Small Business Management: Techniques of marketing, materials, production, Manpower and financial management, crisis management, working capital management, Fixed capital assessment, cash flow analysis, ROI, techniques of decision making. **(6)**

8. Statutory Requirements: Factories Act 1948, Industrial disputes Act 1947, Indian Contract Act, Indian sales and Goods Act, Indian Partnership Act, Central Excise Sales

Tax , Income Tax Act, Value Added Tax (VAT) **(4)**

9. Preparation of project report:

a. Selection of product
b. Process and plant and machinery selection
c. Layout planning
d. Financial viability
e. Marketing and distribution of goods
f. Study of probable reasons of failure **(3)**

10. Business Aspects: Business ethics, export environment, procedure and Documentation, venture capital financing, intellectual property act, patents, GATT. **(2)**

Reference Books:

1. Developing New Entrepreneurs - Entrepreneurship Development Institute of India, Ahmadabad.
2. Handbook of New Entrepreneurs
3. Management of Small Scale Industry - Vasant Desai (Himalaya Publication)
4. Entrepreneurship Playing to Win- Gordon Betty (Taraporwala & Co.)
5. Motivating Economic Achievement- David C. McClelland, David G. Winter
6. Industrial Maharashtra- Facts, Figures and Opportunities (M.I.D.C. Mumbai).
7. Project Planning & Entrepreneurship Development - T. R. Banga
8. Dynamics of Entrepreneurial Development & Management- Vasant Desai (Himalaya Publication)
10. S.S.I. and Entrepreneurship- Vasant Desai (Himalaya Publication)

M.E. (Mechanical-Production Engg.) Semester– II (Revised)

Elective III - 3. PRECISION MANUFACTURING

Teaching Scheme:
3 Lecture Hours per week

Examination Scheme:
Theory Paper (3 hours): 100 Marks

SECTION I

1. Precision Engineering: Definition, difference in precision and accuracy, need for high precision, Classes of achievable machining accuracy – normal, precision, high precision and ultra precision machining; Concept of accuracy – part accuracy, errors of form, errors in flat surface and errors in relative location of surfaces, machining accuracies and the processes **(4)**

2. Geometrical Dimensioning & Tolerancing: Geometrical tolerances, tolerance zones – form, location and orientation of tolerance zones, Datum and precedence – primary, secondary and tertiary, Positional tolerances – zones, form; Combination of dimensional coordinate tolerancing and positional tolerancing, Defining substitute elements (best fit elements) from measured coordinates; Maximum Material Requirements and Minimum (Least) Material Requirements, their applications; Accumulation of tolerances (tolerance stacking) **(6)**

3. Machine Tools & Accuracy: General concept of accuracy of machine tool, spindle rotation accuracy, displacement accuracy, the philosophy of precision machine design, sources of error on a machine tool, factors affecting workpiece accuracy from the point of view of machine

design, accuracy of CNC machines – errors due to input interpolation and servo system; Thermal errors- Sources and transmission of thermal errors in precision machining, error avoidance and compensation, environment control of precision machinery- machine enclosures, room and factory enclosures **(6)**

4. Processing and Accuracy: Dimensional wear of cutting tools and its influence on accuracy, clamping and setting errors, errors due to location; Surface roughness and microfinishing processes – Terminology, influence of machining parameters on surface roughness, Honing, lapping and super finishing, Process capability – mean, variance, skewness, process capability metrics, C_p, C_{pk} **(6)**

5. Methods for Improving Accuracy & Surface Finish: Concept of precision machining, finish turning, finish grinding, precision cylindrical, internal and surface grinding **(3)**

6. Precision Machining Processes: Classification of material removal processes in terms of the energy source used and the tool-workpiece reaction, influence of machining parameters, work material and tool geometry, Diamond turning and milling – machines, tool design and alignment, Fixed abrasive processes - Basic mechanics of grinding, bondless diamond grinding wheels, jig grinding, electrolytic in-process dressing, Ultra-precision grinding, nano-grinding; Loose abrasive processes: polishing, modes of material removal, Chemical mechanical planarization **(5)**

7. Tool Materials for Precision Machining: Classes of tool materials and their properties, coated carbides- laminated, CVD and PVD coated carbides, Cermets, Ceramics - hot pressed, Silicon Nitride and whisker reinforced ceramics, Diamonds – crystallographic planes, natural and synthetic diamonds, polycrystalline diamonds, diamond coated tools, Cubic boron nitrides (CBN), coated CBNs, Tool and work material compatibility **(5)**

8. Applications of Precision Manufacturing: Semiconductor device manufacturing- process steps, Micro electro mechanical devices – applications, Future of precision manufacturing - manufacturing pipeline based on process models and software **(2)**

Reference Books:

1. Murty, R. L. (2009), - Precision Engineering in Manufacturing, (New Age International Publishers) ISBN: 81-224-0750-1
2. Venkatesh, V.C. & Izman, S. (2007), - Precision Engineering, (TMH), ISBN: 0-07-062090-3
3. Dornfeld, David & Lee, Dae-Eun, (2008), - Precision Manufacturing, (Springer Science + Business Media, LLC), ISBN: 978-0-387-32467-8
4. Meadows, James D., (1995), Geometric Dimensioning & Tolerancing, (Marcel Dekker Inc.)
5. G. Henzold, (2006), 2/e, - Geometric Dimensioning & Tolerancing for Design, Manufacturing & Inspection, (Butterworth Heinemann – Elsevier Ltd.), ISBN: 0-7506-6738-9
6. Drake, Paul J. Jr. (1999), - Dimensioning & Tolerancing Handbook, (McGraw Hill), ISBN: 0-07-018131-4

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Elective III – 4. RELIABILITY ENGINEERING

Teaching Scheme:
Lectures 3 Hrs/ week

Examination Scheme
Theory: 100 marks

1. **Definitions:** Causes and types of failures. Reliability expressions for constant, increasing and decreasing hazard rates.
2. **Data Analysis**: Probability plots for various distributions (exponential, Weibull, Normal and Gamma).
3. **Series, parallel, series-parallel, standby and k-out-of-m modeling.**
4. **System reliability evaluation techniques**, including methods of bounds, decomposition and transformation techniques.
5. **Single and Multiple variable inversion techniques** for minimizing system reliability expression.
6. **Analysis of dependent failures:** Reliability computations using similar and dissimilar stress-strength distributions (exponential, Weibull, normal and Gamma).
7. **Time dependent stress-strength distributions:** fatigue failures, Recent trends in reliability evaluation techniques
8. **Maintained systems** and various definitions associated with them. Type of Maintenance. Maintainability analysis,
9. **Markov Models** for reliability, availability and MTTF computations. Renewal Theory Approach. Maintainability design considerations. Life Cycle Costs.
10. **Life/Durability Tests** of devices/ components, environmental testing of components/ circuits/ equipments, vibration and endurance tests.
11. **Study of degradation characteristics**, failure rates of components/ devices under environmental factors.
12. **Accelerated testing**, parameter estimation, accelerated testing of devices and calculation of MTTF

Reference Books:

1. Kumamoto, H., Henley, E., 1996. Probabilistic risk assessment and management for engineers and scientists, 2nd Edition. IEEE Press.
2. Bahr, N., 1997. System safety engineering and risk assessment- a practical approach. Taylor &
   Francis, Washington DC.
3. Henley, E., Kumamoto, H., 1981. Reliability engineering and risk assessment. Prentice-Hall Inc,
   New Jersey.
4. Reliability Engineering, E Balgurusamy, Tata McGraw Hill
5. Andrew K.S.Jardine & Albert H.C.Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.
6. Bikas Badhury & S.K.Basu, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
7. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993.
8. Sushil Kumar Srivastava, Maintenance Engineering and Management, S.Chand

M.E. (Mechanical-Production Engg.) Semester– II (Revised)

Elective III – 5. WORLD CLASS MANUFACTURING

Teaching Scheme: **Examination Scheme**
Lectures 3 Hrs./ week Theory: 100 marks

1. **Models of world class manufacturing**: Hall's framework of value –added engineering, Schonberger's framework of world class manufacturing, Various models of world class manufacturing, JIPM TPM Award, EFQM Award, RBNQA Award
2. **Lean Manufacturing & Services**: Lean Manufacturing tools, Value Stream Mapping, implementation Roadmap.
3. **Techniques related to material processing and handling**: Set-up Time Reduction: SMED Methodology for Set-up reduction, Set-up Reduction Projects. Design of JIT: Flexible Manufacturing Systems (FMS), Reconfigurable manufacturing systems
4. **Concurrent Engineering**, Design for Manufacturability and Assembly (DFMA), Collaborative Product Commerce (CPC)
5. **Group Technology**, Focused Factories and Cellular Manufacturing: Work cell concepts and applications, Work cell design, work cell staffing and equipment issues
6. **Total Productive Maintenance**: Outline of TPM, Production Efficiency, Improvement program for Zero failures, Implementation of Jishu-Hozen activities, Planned Maintenance, Initial-Phase Management, Quality Maintenance, Operation & Maintenance skill Development, Implementation of TPM in the Administrative & Indirect Departments, Zero Accidents & Zero Pollution, Small-Group activities of TPM
7. **Business Process Reengineering**: BPR Concepts, Practices & Philosophy. Key features and guiding principles of Reengineering, Kinds of changes that occur in reengineering, Changes required on Behavioral Side in a BPR Project, Concepts of Business and Core Processes in BPR.

Reference Books:

1. World Class Manufacturing -A strategic perspective by B.S. Sahay, Saxena, Macmillan, India
2. Hammer M. and Champy J. Re-engineering the Corporation - Harper Collins.
3. TPM – New Implementation Program in Fabrication & Assembly Industries By Kunio Shirose Japan Institute of Plant Maintenance
4. Maintainability Engineering – Blanchard & Verma
5. World Class Manufacturing- Case Book-R J Schonberger (Free press)
6. World Class Manufacturing – Richard Schonberger
7. Introduction to TPM: Total Productive Maintenance by Nakajima Seiichi
8. Total Productive Maintenance by Terry Wireman (Industrial Press)

M.E. (Mechanical-Production Engg.) Semester– II (Revised)

Elective III – 6. TOTAL QUALITY MANAGEMENT

Teaching Scheme: **Examination Scheme**
Lectures 3 Hrs/ week Theory: 100 marks

1. Basic concepts, need for TQM, principles of TQM, Quality philosophies of Deming, Crosby, Juran, Ishikawa and Feigenbaum, TQM models.
2. Quality policy deployment, quality function deployment, voice of customer, quality planning
3. QC tools, problem solving methodologies, new management tools, quality circles, quality costs, prevention and appraisal costs, failure costs, models to minimize failure costs, benchmarking
4. Need for ISO 9000 system, advantages, clauses of ISO 9000, Implementation of ISO 9000, QS9000 and TS16949 systems, Introduction to EMS, quality auditing, Case studies.
5. KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods: Introduction to parameter and tolerance design, Six Sigma
6. Steps in TQM implementation, national and international quality awards, case studies.

Reference Books:

1. Dale H. Besterfiled, "Total Quality Management", Pearson Education Asia
2. Rose, J.E. Total Quality Management, Kogan Page Ltd. 1993.
3. John Bank, The essence of total quality management, Prentice Hall, 1993.
4. Greg Bounds and Lyle Yorks, Beyond Total Quality Management, McGraw Hill, 1994.
5. Masaki Imami, KAIZEN, McGraw Hill, 1986.
6. Phil Crosby, Quality Without Tears, McGraw Hill
7. Six Sigma: Hemant Urdhwareshe.

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Elective IV – 1. PLASTIC PROCESSING & DIE DESIGN

Teaching Scheme: **Examination Scheme**
Lectures 3 Hrs/ week Theory: 100 marks
Practical: 1 Hr/ Week Term work: 25 marks

1. **Plastic materials**

Classification of plastic materials, their physical and mechanical properties, selection of plastics for various applications, advantages and limitations of using plastics.

2. **Melt Processing Techniques:**

Polymer processing techniques such as extrusion, compression and transfer molding. Injection molding, blow molding, thermoforming, rotational molding, calendaring, Bag molding reaction molding. Classification of polymer processing operations. Simple model flows for analysing processing operations with examples.

3. **Constructional Features Molds:**
constructional features of core and cavity plates, mold size and strength, cavity material, and fabrication, mold placement, constructional features and layout of runners and gates.
4. **Product Design of Molded Products:**
Various considerations such as wall thickness, fillets and radii, ribs, under, cuts, drafts, holes, threads, inserts parting lines, etc. surface treatment mould design for avoiding warpage. Standards for Tolerances on moulded articles.
5. **Design of Molds for Plastic Processing**
Methodical mold design, determination of economical number of cavities, melt rheology, temperature control of injection molds, calculation of mold opening force and ejection force. Detail design of cooling system, ejection system and gating system. Molding thermoplastics, thermosets, expandable polystyrene, foamed engineering plastics, molds for reaction injection molding.
6. **Computer Applications in Plastic Molding**
Use of various software packages for mold flow analysis, optimum gate location and defect analysis, design of component for balanced flow, optimization of process parameters of plastic molding.

Term Work:
Minimum Six assignments including mold designing for different processes involving use of suitable software

Reference Books:
1. A.W. Birley, B. Howarth, Hana, "Mechanics of plastics processing properties",
2. J.E. Mark, R. West, (1992), "Inorganic Polymers", H.P. Alocock, Prentice Hall,
3. Fried, "Poly. Science and Technology", Prentice Hall
4. Frados, "Plastic Engg. Hand Book"
5. Patton , "Plastic Technology"
6. Glanill , "Plastic Engg. Data Book"
7. Charles Harper, "Handbook of Plastics Technologies", McGraw-Hill.
8. RJW Pie, (1989), Mould & Die Design, 4/e, –Longman
9. Injection Molding Handbook- Tim A. Osswald, Lih-Sheng Turng, Paul J. Gramann, Hanser Verlag, 2008

M.E. (Mechanical – Production Engg.) Semester– II (Revised)

ELECTIVE IV - 2. AUTOMATIC CONTROL ENGINEERING

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 marks
Practical: 1 Hr/Week	Term Work: 25 marks

Course Objective
To study the fundamentals of control engineering theory.

1. Introduction to Automatic Control Systems:-Basic definition, Structure of a feedback systems, closed loop and open loop control systems. Laplace Transformation, Building blocks

and transfer functions of mechanical, electrical, thermal and hydraulic systems. Mathematical models of physical systems, control systems components. Systems with dead time, control hardware and their models, Electro-hydraulic valves, hydraulic servomotors, synchros, LVDT, electro-pneumatic valves, pneumatic actuators. **(8)**

2. Basic characteristic of feedback control systems:-Stability, steady state accuracy, transient accuracy, disturbance rejection, insensitive and robustness, Basic models of feedback control systems:-Proportional, integral, derivative and PID, feed forward and multi loop control configurations, stability, concept of relative stability. **(8)**

3. Root locus and frequency response methods, stability in frequency domain, frequency domain methods of design, compensation and their realization in time and frequency domain, improving system performance,. **(8)**

4. Design of Lead lag compensators, OpAmp based and digital implementation of compensators, Tuning of process controllers. **(4)**

5. Introduction to design, sample data control systems, stable variable analysis and design, optimal control systems. **(4)**

6. Introduction to non linear control systems, discrete time systems and Z-Transformation methods, Microprocessor based digital control, State space analysis, Optimal and adaptive control systems. **(5)**

Term Work:

Term Work shall consist of four design/control problems solved using MATLAB and three assignments based on the above topics. Additional exercises using Bond Graphs for system modelling are desirable.

Reference Books:

1. F.H.Raven,"Automatic Control Engineering", Third edition, McGraw Hill, 1983.
2. K.Ogata,"Modern Control Engineering", PHI, Estern Economy Edition, 1982.
3. I.J.Nagrath, M.Gopal,"Control Systems Engineering".
4. B.C.Kuo, "Automatic Control Systems".
5. Schaum Series," Theory and Problems of Feedback and Control Systems". (MGH)
6. Miller R.W.,"Servo Mechanism Devices and Fundamentals".
7. Dr.N.K.Jain,"Automatic Control Systems Engineering", Dhanpat Rai Publishing Company.
8. Jack Golten, Andy Verwer, "Control System Design and Simulation", McGraw Hill

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Elective IV – 3. ENTERPRIZE RESOURCE PLANNING (ERP)

Teaching Scheme:
Lectures 3 Hrs/ week
Practical: 1 Hrs/ Week

Examination Scheme
Theory: 100 marks
Term work: 25 marks

Enterprise Recourse Planning

OBJECTIVES

- To know the basics of ERP
- To understand the key implementation issues of ERP
- To know the business modules of ERP
- To be aware of some popular products in the area of ERP
- To appreciate the current and future trends in ERP

1. **Introduction:** ERP- An Overview, Enterprise – An Overview, Benefits of ERP, ERP and Related Technologies, Business Process Reengineering (BPR), Data Warehousing, Data Mining, OLAP, SCM
2. **ERP Implementation:** ERP Implementation Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring
3. **The Business Modules:** Business modules in an ERP Package, Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution
4. **ERP and Supply Chain Management (SCM):** ERP and Business Process Reengineering (BPR), ERP and Integrated Management Systems, ERP and Multi-plant management, ERP and Enterprise Paperless Management
5. **The Erp Market:** ERP Market Place, SAP AG, Peoplesoft, Baan, JD Edwards, Oracle, QAD, SSA
6**. ERP – Present and Future**: Turbo Charge the ERP System, EIA, ERP and e-Commerce, ERP and Internet, Future Directions
7. **ERP System in India**
8. **ERP Justification**: Cost / Benefit analysis, Tangible and intangible benefits, challenges in their computation & subsequent measurement and associated best practices, Selection of ERP systems.

Term Work:
Minimum SIX assignments based on above syllabus including two case studies.

Reference Books:

1. Alexis Leon, "ERP Demystified", Tata McGraw Hill, New Delhi, 2000
2. Joseph A Brady, Ellen F Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Thompson Course Technology, USA, 2001.
3. Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning – Concepts and Practice", PHI, New Delhi, 2003

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Elective IV - 4. INDUSTRIAL AUTOMATION & ROBOTICS

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 1 Hr. per week

Examination Scheme:
Theory Paper: 100 marks
Term Work: 25 marks

1. Introduction: Automated manufacturing systems, fixed /programmable /flexible automation, need; Basic elements of automated systems- power, program and control; 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. **(7)**

2. Transfer Lines: Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications; Analysis of transfer lines without and with storage buffers. **(4)**

3.Assembly Automation: Types and configurations, Parts delivery at workstations- Various vibratory and non-vibratory devices for feeding and orientation, Calculations of feeding rates, Cycle time for single station assembly machines and partially automated systems; Product design for automated assembly. **(5)**

4. Fundamentals of Industrial Robots: Specifications and Characteristics, Basic components, configurations, Criteria for selection, various industrial applications. **(4)**

5. Robotic Control Systems: Drives, Robot Motions, Actuators, Power transmission systems; Robot controllers, Dynamic properties of robots- stability, control resolution, spatial resolution, accuracy, repeatability, compliance. **(5)**

6. Robotic End Effectors and Sensors: Transducers and sensors- sensors in robotics and their classification, Touch (Tactile) sensors, proximity and range sensors, force and torque sensing, End Effectors- Types, grippers, Various process tools as end effectors; Robot-End effector interface, Active and passive compliance, Gripper selection and design. **(7)**

7. Robot Programming: Lead through method, Robot program as a path in space, Methods of defining positions in space, Motion interpolation, branching; Textual robot programming languages. **(4)**

Term Work:

Minimum Six exercises including analysis, modeling, simulation and programming of industrial robotic systems.

Reference Books:

1.Groover, M.P., (2004), "Automation, Production Systems & Computer Integrated Manufacturing" 2/e, (Pearson Edu.) ISBN: 81-7808-511-9

2.Morris, S.Brian (1994), "Automated Manufacturing Systems", (McGraw Hill) ISBN: 0-07-113999-0

3.Pessen, David W.(1990), "Industrial Automation, Circuit Design & Components", (John Wiley & Sons, Singapore)

4.Groover, M.P.; Weiss, M.; Nagel, R.N. & Odrey, N.G. "Industrial Robotics, Technology, Programming & Applications", (McGraw Hill Intl. Ed.) ISBN:0-07-024989-X

5.Fu, K.S.; Gonzalez, R.C. & Lee, C.S.G. "Robotics-Control, Sensing, Vision and Intelligence", (McGraw Hill Intl. Ed.) ISBN:0-07-100421-1

6.Keramas, James G. (1998), " Robot Technology Fundamentals",(CENGAGE) ISBN: 981-240-621-2

7.Noff, Shimon Y. "Handbook of Robotics", (John Wiley & Sons)

8.Niku, Saeed B. (2002), "Introduction to Robotics, Analysis, Systems & Applications" , (Prentice Hall of India)

9.Koren, Yoram "Robotics for Engineers", (McGraw Hill)

10. Schilling, Robert J.(2004), "Fundamentals of Robotics, Analysis & Control", (Prentice Hall of India), ISBN: 81-203-1047-0
11. Robotics: Modeling, Planning & Control, B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo (2011), Springer, ISBN: 9788132203032.

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Elective IV – 5. PROJECT MANAGEMENT

Teaching Scheme:
Lectures 3 Hrs/ week
Practical: 1 Hrs/ Week

Examination Scheme
Theory: 100 marks
Term work: 25 marks

1. Introduction: Foundations of Project Management, Project Life Cycle, Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.
2. Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modeling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations
3. Network analysis: Shortest path method, minimal spanning tree, Floyd and Dijkastra algorithm
4. PERT/COST Accounting, Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Crashing
5. Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.
6. Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management

Term work:

Six assignments based on above syllabus, consisting of quantitative treatment to industrial problems.

Reference books:

1. Project Management – A Managerial Approach, by Jack R. Meredith, and Samuel J. Mantel Jr., John Wiley and Sons, 2006
2. Project Management – A Systems Approach to Planning, Scheduling and Controlling, by Harold Kerzner, John Wiley and Sons, 2006
3. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill

M.E. (Mech.-Prod. Engg.) Semester– II (Revised)

8. SEMINAR – II

Teaching Scheme:	**Examination Scheme:**
Practical: 1 Hour/ Week	Term Work: 25 marks

Seminar - II should be based on the literature survey on any topic relevant to manufacturing engineering and management. It may be leading to selection of a suitable topic of dissertation. The report shall contain some contribution by the candidate in the form of experimental results, deductions, compilation and inferences etc.

Each student has to prepare a write-up of about 25 pages. The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department.

The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

M.E. (Mechanical-Production. Engg.) Semester– III (Revised)

1. SEMINAR- III

Teaching Scheme:	**Examination Scheme:**
Practical: 1 Hour/ Week	Term Work: 25 marks
	Oral Examination: 25 Marks

Seminar - III shall be based on topic of the Dissertation Work. It may include literature review, required theoretical input, study and comparison of various approaches for the proposed dissertation work. The candidate shall prepare a report of about 25 pages. The report typed on A4 sized sheets and bound in the prescribed format shall be submitted after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work by the evaluation committee(*) appointed by the Head of the Department.

DISSERTATION

The dissertation work to be carried out individually commences in the Semester III and extends through Semester IV. The topic of dissertation work related should be related to the areas of Mechanical/Production Engg. applications. Applications of computer as a tool for conceptualization, design, analysis, optimization, manufacturing, manufacturing planning /management, quality engineering, simulation of products / processes / mechanisms / systems, experimental study, etc. are to be encouraged and preferred.

SYNOPSIS APPROVAL

The Head of the Department shall appoint a committee comprising of the Guide and two experts to review and approve the synopses before submitting them to the University for approval. The candidates shall submit the synopsis to the University authorities for approval in the prescribed format before the due date.

M.E. (Mechanical-Production. Engg.) Semester– III (Revised)

2. DISSERTATION PHASE - I

Teaching Scheme:	**Examination Scheme:**
Practical: 4 Hour/ Week	Term Work: 50 marks
	Oral Examination: 50 marks

It shall include the problem definition, literature survey, approaches for handling the problem, finalizing the methodology for the dissertation work and design calculations / experimental design etc. A report of the work shall be submitted at the end of Semester III after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work, by the evaluation committee (*) appointed by the Head of the Department, for appropriateness, sufficiency of contents and offer suggestions if any.

M.E. (Mechanical-Production. Engg.) Semester– IV (Revised)

1. DISSERTATION PHASE II

Teaching Scheme:	**Examination Scheme:**
Practical: 6 Hour/ Week	Term Work: 200 marks
	Oral Examination: 100 Marks

The candidate shall submit the detailed report as per the synopsis approved by the university, of the dissertation work in the prescribed format after approval by the Guide and endorsement by the Head of the Department. It will be assessed for term work by the evaluation committee (*) appointed by the Head of the Department, for completion of the proposed work.

(*) Note: The evaluation committee shall consist of the Guide, one senior expert faculty member and the Head of the Department or his/her representative.

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