

UNIVERSITY OF MUMBAI



Revised Syllabus for the M. E. Program
Program: M. E. (Mechanical Engineering)
MANUFACTURING SYSTEMS ENGINEERING

(As per Credit Based Semester and Grading System with
effect from the academic year 2012–2013)

**Program Structure for
ME Mechanical Engineering (Manufacturing Systems Engineering)
Mumbai University
(With Effect from 2012-2013)**

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
MSC101	Product Design & Development	04	--	--	04	--	--	04	
MSC102	Computer Integrated Manufacturing Systems	04	--	--	04	--	--	04	
MSC103	Quality & Reliability Engineering	04	--	--	04	--	--	04	
MSE101X	Elective I	04	--	--	04	--	--	04	
MSE102X	Elective II	04	--	--	04	--	--	04	
MSL101	Laboratory I – Computer Integrated Manufacturing Systems	--	02	--	--	01	--	01	
MSL102	Laboratory II – Quality & Reliability Engineering	--	02	--	--	01	--	01	
Total		20	04	--	20	02	--	22	
Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract./oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MSC101	Product Design & Development	20	20	20	80	03	--	--	100
MSC102	Computer Integrated Manufacturing Systems	20	20	20	80	03	--	--	100
MSC103	Quality & Reliability Engineering	20	20	20	80	03	--	--	100
MSE101X	Elective I	20	20	20	80	03	--	--	100
MSE102X	Elective II	20	20	20	80	03	--	--	100
MSL101	Laboratory I - Computer Integrated Manufacturing Systems	--	--	--	--	--	25	25	50
MSL102	Laboratory II - Quality & Reliability Engineering	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	50	50	600

Subject Code	Elective I	Subject Code	Elective II
MSE1011	Design of Experiments	MSE1021	Financial Management & Costing
MSE1012	Advance Material Science	MSE1022	Enterprise Resource Planning
MSE1013	Performance Measurement & Benchmarking	MSE1023	Research Methodology
MSE1014	Precision Engineering	MSE1024	Project Management

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
MSC201	Sustainable Manufacturing	04	--	--	04	--	--	04	
MSC202	Mechatronics and Industrial Automation	04	--	--	04	--	--	04	
MSC203	Advanced Quantitative Techniques	04	--	--	04	--	--	04	
MSE203X	Elective III	04	--	--	04	--	--	04	
MSE204X	Elective IV	04	--	--	04	--	--	04	
MSL203	Laboratory III - Mechatronics & Industrial Automation	--	02	--	--	01	--	01	
MSL204	Laboratory IV - Advanced Quantitative Techniques	--	02	--	--	01	--	01	
Total		20	04	--	20	02	--	22	
Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract./oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MSC201	Sustainable Manufacturing	20	20	20	80	03	--	--	100
MSC202	Mechatronics & Industrial Automation	20	20	20	80	03	--	--	100
MSC203	Advanced Quantitative Techniques	20	20	20	80	03	--	--	100
MSE203X	Elective III	20	20	20	80	03	--	--	100
MSE204X	Elective IV	20	20	20	80	03	--	--	100
MSL203	Laboratory III - Mechatronics & Industrial Automation	--	--	--	--	--	25	25	50
MSL204	Laboratory IV - Advanced Quantitative Techniques	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	50	50	600

Subject Code	Elective III	Subject Code	Elective IV
MSE1031	World Class Manufacturing	MSE1041	Business Intelligence
MSE1032	Product Life Cycle Management [@]	MSE1042	Manufacturing Strategy
MSE1033	Logistics & Supply Chain Management	MSE1043	Entrepreneurship Development
MSE1034	Micro Electro Mechanical Systems [@]	MSE1044	Micro & Nano Manufacturing Systems

@ Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Manufacturing Systems Engineering

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
MSS301	Seminar	--	06	--	--	03	--	03	
MSD301	Dissertation I	--	24	--	--	12	--	12	
Total		--	30	--	--	15	--	15	
Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test 2	Avg.					
MSS301	Seminar	--	--	--	--	50	50	100	
MSD301	Dissertation I	--	--	--	--	100	--	100	
Total		--	--	--	--	150	50	200	

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
MSD401	Dissertation II	--	30	--	--	15	--	15	
Total		--	30	--	--	15	--	15	
Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test 2	Avg.					
MSD401	Dissertation II	--	--	--	--	100	100	200	
Total		--	--	--	--	100	100	200	

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher

Subject Code	Subject Name	Credits
MSC101	PRODUCT DESIGN & DEVELOPMENT	04
Module	Detailed Content	Hours
1	1.1 Introduction: Classification/ Specifications of Products. 1.2 Product life cycle. Product mix. 1.3 Introduction to product design. 1.4 Modern product development process. 1.5 Innovative thinking. 1.6 Morphology of design.	08
2	2.1 Conceptual Design: Generation, selection & embodiment of concept. 2.2 Product architecture. 2.3 Industrial design: process, need. 2.4 Robust Design: Taguchi Designs & DOE. 2.5. Design Optimization	10
3	3.1 Design for Mfg & Assembly: Methods of designing for Mfg & Assy. 3.2 Designs for Maintainability. 3.3 Designs for Environment. 3.4 Product costing. 3.5 Legal factors and social issues .Engg ethics and issues of society related to design of products .	12
4	4.1 Value Engineering / Value Analysis. : Definition. Methodology. 4.2 Case studies. 4.3 Economic analysis: Qualitative & Quantitative.	10
5	5.1 Ergonomics / Aesthetics: Gross human autonomy. 5.2 Anthropometry. 5.3 Man-Machine interaction. 5.4 Concepts of size and texture, colour .Comfort criteria. 5.5 Psychological & Physiological considerations. 5.6 Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.	10
6	6.1 Concurrent Engg , 6.2 Rapid prototyping , 6.3 Tools for product design – Drafting / Modeling software. 6.4 CAM Interface. 6.5 Patents & IP Acts. Overview, Disclosure preparation.	10

References:

1. Karl T Ulrich, Steven D Eppinger , “ Product Design & Development.” Tata McGrawhill New Delhi 2003
2. David G Ullman, “The Mechanical Design Process.” McGrawhill Inc Singapore 1992
3. N J M Roozenberg , J Ekels , N F M Roozenberg “ Product Design Fundamentals and Methods .” John Willey & Sons 1995
4. Kevin Otto & Kristin Wood Product Design: “Techniques in Reverse Engineering and new Product Development.” 1 / e 2004 , Pearson Education New Delhi
5. L D Miles “Value Engineering.”
6. Hollins B & Pugh S “Successful Product Design.” Butterworths London.
7. Baldwin E N & Neibel B W “Designing for Production.” Edwin Homewood Illinois
8. Jones J C “Design Methods.” Seeds of Human Futures. John Willey New York.
9. Bralla J G “Handbook of Product Design for Manufacture, McGrawhill New York.

Assessment

Internal : Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MSC102	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	04
Module	Detailed content	Hours
1	<p>Fundamentals of Manufacturing and Automation: Production operations and Automation in Production Systems, types of automation, Automation Principles & Strategies, Advance mfg. techniques like Digital manufacturing, RPT etc</p> <p>CIM Automation: Computer applications in Design and manufacture- Fundamentals of CAD, CAE, CAM. Introduction to CIM, Evolution, objectives, benefits, limitations, relationship between automation and CIM, reasons for automating, arguments for and against automation.</p>	08
2	<p>High -Volume Production Systems: Automated flow lines, methods of work part transport, transfer mechanisms, buffer storage, analysis of flow lines without storage and with storage buffer, assembly systems, automated assembly system and its types, parts feeding devices, analysis of single stage and multistage assembly machines.</p>	10
3	<p>Development and implementation of an FMS: Planning phase, Integration, System configuration, FMS layouts, Simulation, FMS Project development steps. Project management, Equipment development, Host system development, planning, Hardware & Software development. Automated Material Handling & Storage: Functions, Types, Analysis of material handling equipments, Design of Conveyor & AGV systems. Problems. Development for total material handling system.</p>	12
4	<p>Computer Aided Quality Control (CAQC): Introduction, QC inspection and testing, the computer in QC, Automated inspection principles and methods, sensor technologies for automated inspection – contact and non contact types, computer aided testing, Integration of CAQC with CAD/CAM.</p>	10
5	<p>Role of Information Systems: Information requirements of manufacturing, group technology, computer aided process planning, computer integrated production planning systems, material requirements planning, capacity planning, shop floor control, automatic identification techniques, Computer networks for manufacturing, Database requirements of Computer Integrated Manufacturing.</p>	10

6	<p>Robots and Machine Intelligence:</p> <p>Robots: Basic structures of Robots, Resolution, Accuracy & Repeatability, Classifications & structures of Robotic Systems: Point to Point Continuous path systems, Trajectory Planning, Control loop of Robotic Systems. Concepts of fifth generation computing, programming AI environment, developing artificial intelligence system, definition of Expert systems, Natural Language processing, neural networks.</p> <p>Tools for Machine Thinking: Forward chaining, Backward chaining, use of probability and fuzzy logic.</p>	10
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References:

1. Groover, M.P: “Automation, Production System and CIM”- Prentice-Hall of India.
2. Vajpayee, “Principles of CIM” - Prentice-Hall of India.
3. Ranky, Paul G: “Computer Integrated Manufacturing”- Prentice-Hall of India.
4. David Bedworth: “Computer Integrated Design and Manufacturing” -TMH, New Delhi.
5. Robert Levine et al;” A Comprehensive guide to AI and Expert Systems”- McGraw Hill Inc, 1986.
6. Mohsen Shahinpoor – Harper & Row publishers, New York. “A Robot Engineering Textbook
7. “Robotics, control vision and intelligence,” Fu, Lee and Gonzalez. McGraw Hill International.
8. Geoffrey Boothroyd, “Assembly Automation and Product Design”, (Manufacturing Engineering and Materials Processing)
9. Radhakrishnan.P, Subramanyan. S, 'CAD/CAM/CIM', New Age International Publishers
10. Horst Tempelmeier and Heinrich Kuhn “Flexible Manufacturing Systems: Decision Support for Design and Operation”

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Subject Code	Subject Name	Credits
MSC103	QUALITY & RELIABILITY ENGINEERING	04
Module	Detail Contents	Hrs
1	<p>Quality :</p> <p>historical review, definitions & terminology, Q.A., TQC & CWQIP, pillars of TQM, System approach to TQM, introduction to TQM models , top management role, global standards like ISO 9001, ISO14000, TS16949/QS9000, Introduction to current addition to ISO standards, various quality ‘gurus’& their contribution, management & operator oriented quality issues. Quality of design; Quality of conformance & performance, Quality tasks, organizing for quality, quality costs & means to control them., Quality leadership & Quality strategic planning.</p>	15
2	<p>Process Control for variables:</p> <p>definition of SQC, Q.A., TQC & CWQIP benefits and limitation of SQC, Quality control: Quality cost-Variation in process causes of variation –Theory of control chart- uses of control chart – Control chart for variables – X chart, R chart and σ chart -process capability – process capability studies and simple problems. Six sigma concepts.</p>	15
3	<p>Process Control for attributes</p> <p>Control chart for attributes –control chart for non conforming– p chart and np chart –control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.</p> <p>Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer’s Risk and consumer’s Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans</p>	15
4	<p>Modern management trends and concepts:</p> <p>Productivity & reliability as angles of quality, basic & modern tools in total quality improvement, process capability, OC curves, innovative Kaizen,5-S, Poka-yoke, JIT, Kanban ,QFD, Taguchi approach to robust designs, Concurrent engineering., FMEA, process evaluation by DOE, introduction to RSM, Kaneisi method, World class manufacturing.</p>	15

References:

1. Douglas.C.Montgomery, "Introduction to Statistical quality control" John wiley 4th edition 2001.
2. John.S. Oakland. "Statistical process control", Elsevier, 5th edition, 2005
3. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 1993
4. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 1996
5. Besterfield D.H., "Quality Control", Prentice Hall, 1993.
6. Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publishers, 1998.
7. Danny Samson, "Manufacturing & Operations Strategy", Prentice Hall, 1991
8. J.Juran, "Quality Control Handbook, McGraw Hill USA
9. A.V. Feigenbaum, "Total quality control" McGraw hill int. edition USA
10. W.E. Deming, "Out of crisis", productivity & quality publishing pvt.ltd., Chennai.
11. A.J. Duncan, "Quality control & Industrial statistics", Richard D. Irwin, INC USA.
12. A. Zaidi, "SPC, concepts, Methodology & tools", Prentice Hall India ltd., New Delhi

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Subject Code	Subject Name	Credits
MSE1011	DESIGN OF EXPERIMENTS	04
Module	Detailed content	Hours
1	Introduction, Background and Overview: A brief history of DOE-When to use DOE- Basic principles of DOE & Some typical applications. Overview of basic statistical concepts, Simple Comparative Experiments, Single Factor experiments, Randomized Blocks, Latin Square Designs and extensions. Testing of Hypothesis ('T' & 'F' test), Introduction to Factorial Designs, 2^k Designs.	06
2	Full Factorial Design: ANOVA, The basics of "full factorials", Factorial effects and plots	10
3	Two & Three Level Fractional Factorial Design: Objective, The one-half fraction and one-quarter of the 2^k design, 2^{k-p} fractional factorial design, 3-level & Mixed-level Factorials & Fractional Factorials.	12
4	The Robust Design: basics of robust designs, Taguchi designs, robust design example.	12
5	Response Surface Methodology: First & second order experiments, Analysis of second-order response surfaces, Central composite designs, Plackett-Burman designs, process optimization & reliability improving experiments	10
6	Experiment Design According to Shainin: Multi-variate charts, components search, paired comparisons	10

References:

1. Box, GEP, Hunter, WG, and Hunter, JS, 1978, Statistics for Experimenters, Wiley.
2. Box, GEP and Draper, NR 1987, Empirical Model-Building and Response Surfaces, Wiley.
3. Cochran, WG and Cox, GM, 1957, Experimental Designs, Wiley.
4. Fisher, RA, 1966, The Design of Experiments, 8th edit., Hafner.
5. Hinkelmann, K and Kempthorne, O, 1994, Design and Analysis of Experiments (Vol I), Wiley.
6. Pukelsheim, F, 1993, Optimal Design of Experiments, Wiley.
7. Winer, BJ, 1962, Statistical Principles in Experimental Design, 2nd edit., McGraw-Hill.
8. Robust product design by G.Taguchi
9. Design and Analysis of Experiments, 5th edition, by D.C. Montgomery, John Wiley & Sons, New York, 2001

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Subject Code	Subject Name	Credits
MSE1012	ADVANCED MATERIALS SCIENCE	04
Module	Detailed content	Hours
1	Review of fundamentals: Covalent, Ionic, Metallic and Van-der Waals Bond, Bond strength and melting point, Crystalline structures, Vacancies, Dislocations and other crystal defects. Metals Vs Alloys – Microstructure characterization	06
2	Mechanical behavior of metals and alloys: Tensile & compressive stress-strain relations, fracture toughness, fatigue, creep, wear and abrasion.	06
3	Modern Metallic Materials: HSLA (High strength low alloy) Steels, tool and die materials, alloy cast-irons, stainless steels, PH and Maraging steels, materials for low temperature applications, refractory metals and super alloys, hard field steels, ball bearing steels, automobile alloys and aerospace alloys. Nano crystalline materials.	08
4	Polymers: A. Definitions, Classifications, Monomers, Polymerization principles, Addition, Condensation, Mass, Suspensions and emulsion polymerizations Classification – Thermoplastic and Thermosets, Crystalline and Amorphous, Natural and Synthetic, Linear, branched and cross-linked; Engineering, commodity and speciality polymers, Homo polymers and co-polymers, Elastomers and Thermoplastic elastomers Polymer Blends and Alloys, Liquid crystal polymers, Polymer foams B. Properties and applications of polymers, Viscoelastics, Thermal, Electrical, Optical, Environmental & Mechanical behaviour; Important thermoplastics and thermosets - their moulding characteristics, properties and applications C. Additives Important additives- Need and Significance, Types and uses	14
5	Ceramics: A. Various ceramic materials and their applications Engineering ceramics, Environmental influence on ceramics Ceramic crystal structures – Binary and Ternary structures. B. Introduction to phase equilibria in ceramics: Phase equilibrium diagrams and composition calculations Thermal, electrical, magnetic, optical and mechanical behaviour of ceramics.	10

6	<p>Composites:</p> <p>A. Fundamentals: Definition, Classification of composite materials, Laws of mixtures, Factors affecting composite properties, Interfacial bonding</p> <p>B. Mechanical Behaviour of Composites: Young's Modulus and strength considerations for continuous FRCs and short FRCs.</p> <p>C. Interfacial Mechanics: Mechanics of load transfer from matrix to fibre, Toughening mechanisms in composites</p> <p>D. Fabrication and Properties of Fibers: Glass fibres, Carbon fibres, Silicon Carbide fibres, and Metallic Glasses</p> <p>E. Comparative Study, Illustrations & Applications: PMCs, CMCs & MMCs</p> <p>F. Fatigue of Laminate Composites</p> <p>G. Nano composites: Applications</p>	16
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References :

1. Materials Science by R S Khurmi & R S Sedha S Chand & Co
2. Mechanical Metallurgy by Georgr Dieter (Mc Grawhill)
3. Heat Treatment Principles By Rajan , Sharma & Sharma Prentice Hall
4. Plastics Engg by R J Crawford Butterworth Hieneman
5. Plastics Technology Handbook by M Chandra & S K Roy Marcel Dekker
6. Mechanical properties of ceramics by John B Wactman John Willey & Sons
7. Composite Materials Scence & Engineering by Krishnan Chawla (Springer Verlag)
8. Metal Matrix composites : Thermomechanical beheaviour by Taya M & Arsenault R J (Pergamon press oxford)
9. Analysis & performance of fibre composites by B D Agarwal & L J Broutman John Willey & sons New York

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Subject Code	Subject Name	Credits
MSE1013	PERFORMANCE MEASURES & BENCHMARKING	04
Module	Detailed Content	Hours
1	Fundamentals of Performance Measures & Benchmarking Introduction to Performance Measures – Importance of Benchmarking – Objectives of Performance Measures - Effect of Performance Measures on Business Enterprises- Types of Performance Measures- Selection of Performance Measures context to Business- Performance Measures vs Benchmarking.	12
2	Performance Measures of Manufacturing Enterprises Productivity – Efficiency – Cost Effectiveness – Quality – Trading – Overall Efficiency – Technology Integration (Definition, Importance and its effect on enterprise performance) – Co-relation of these performance measures and its effects on manufacturing processes - Performance Matrix.	10
3	Competitive Advantage Value - Cost- Meaning of Competitive Advantage – Value Chain – Cost Advantage - Manufacturing Strategy vs Competitive Advantage – Technology and Competitive Advantage –	10
4	Benchmarking in Manufacturing Process Meaning of Bench Marking – Steps employed in Bench marking process – Types of Bench Marking – Generic – Functional – Competitive - Internal Benchmarking	08
5	Management of Technology Introduction – New Paradigm - Role of Technology in the Creation of Wealth – Critical Factors in Managing Technology – Competitiveness – Technology Transfer – Measurement of Intellectual & Human Capital.	10
6	Performance Measures & Benchmarking: Re-engineering Re engineering – Rethinking of business process – Enabling role of Information Technology – Quality Management – Total Quality Management & Six Sigma – Advance Statistics – Mean – Standard Deviation - Mode – Median.	10

References:

- 1) Quantitative Model for Performance Evaluation and Bench Marking By, Joe Zhu, Kluwer Academic Publishers, Norwell, USA
- 2) Hammer, Michael, and Champy, James. (1993). *Reengineering the Corporation: A Manifesto for Business Revolution*. New York: Harper Collins.
- 3) Competitive Advantage by Michael E. Porter, The Free Press, New York (1985)
- 4) Management of Technology, by Tarek M. Khalil, McGraw Hill Publications 2000
- 5) Production and Operations Management by S. N. Chary, McGraw Hill Publications 2004

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Subject Code	Subject Name	Credits
MSE1014	PRECISION ENGINEERING	04
Module	Detailed Content	Hours
1	Concepts Of Accuracy: Introduction - concept of accuracy of machine tools - spindle and displacement accuracies - Accuracy of numerical control systems - Errors due to numerical interpolation - Displacement measurement system and velocity lags.	07
2	Geometric Dimensioning And Tolerancing: Interpretation, measurement and application of form tolerances - datum system and targets –tolerance of position Tolerance zone conversions - Surfaces, features, features of size, datum features-Datum, oddly configured and curved surfaces as datum features, equalizing datum.	07
3	Surface and form metrology : Flatness, roughness, waviness cylindricity etc. Methods of improving accuracy & surface finish, Influence of forced vibration on accuracy, Dimensional wear of cutting tools and its influences on accuracy	08
4	Precision Measuring Systems: Units of length - legal basis for length measurement – Traceability - Processing system of nanometer accuracies - LASER light source - LASER interferometer - LASER alignment telescope - LASER micrometer-on-line and in-process measurements of diameter and surface roughness using LASER - Micro holes and topography measurements -.- In processing or in-situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.- Straightness and flatness measurement – Optoelectronic Measurement Systems in Metrology, Opto electronic devices contact and non contact types Applications - Tool wear measurement - 3D Surface roughness - Pattern generation studies.	14
5	Nano-Positioning Systems Of Nano Accuracy & Repeatability: Guide systems for moving elements - Servo control systems for tool positioning - Computer Aided digital and ultra precision position control.	14
6	Computer Integrated Quality Assurance: Concept of Total quality control & quality assurance - Zero defects-POKA-YOKE Statistical evaluation of data using computer- CNC CMM applications - Computer Aided measurement, data integration of 3D-CMM	10

References:

1. MURTHY,R.L., - " Precision Engineering in Manufacturing ", New age International(P) Limited, publishers, 1996.
2. JAMESD. MEADOWS, - "Geometric Dimensioning and Tolerancing ", Marcel Dekker Inc.1995.
3. "Dimensioning and tolerancing of mass production", Prentice Hall, 1983
4. WATSON .J., " Optoelectronics " - Van Nostrand Rein hold(UK)Co ltd.,1988
5. ROBERT.G. SEIPPEL, - "Optoelectronics for technology and engineering ", Prentice Hall NewJersey,1989
6. ULRICH-REMBOLD, ARMBRUSTER AND ULZMANN-" Interface technology for computer controlled manufacturing processes ", Marcel Dekker Pub. New York, 1993
7. Engg.Metrlogy by Shotbolt.
8. THOMAS.G.G. - "Engineering metrology", Butterworth PUB.1974.
9. NORIO TANIGUCHI, - " Nano Technology ", Oxford university,Press,1996.

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Subject Code	Subject Name	Credits
MSE1021	FINANCIAL MANAGEMENT & COSTING	04
Module	Detailed content	Hours
1	Introduction to the financial statements from typical annual reports of the organizations, Role of accountant, basic accounting concepts and principles. Double entry bookkeeping, Books of prime entry. The use of computer software's in the processing of data, the role of journal,	10
2	Presentation formats of Financial Statements Trial balance, Profit and Loss concepts, Fixed and current parts of Liabilities and assets, Preparation of Profit and Loss Accounts and Balance Sheet, Review of performance, Financial Ratios	14
3	Costing and Cost Control Introduction, Elements of cost, Methods of costing: Introduction, features, application, procedure, cost sheet, cost statement Job Costing, Process costing, joint products and by-products. Equivalent production, contract costing and farm costing,	14
4	Techniques of costing Introduction, merits and de merits Absorption costing, standard costing marginal costing and uniform costing, budgetary control	10
5	Overheads: Definitions, classification, methods of allocation and absorption of various overheads	08
6	Profitability: Introduction, techniques	04

References:

1. Accounting for Management. Dr. Jawahar Lal
2. Accounting for Management. Dr.Khan and Jain
3. Fundamentals.of Financial Management: Dr. Prasanna Chandra, Tata McGraw Hill Publishing Co. Ltd. (4th Edition).
5. Financial Management. Mr. Bhattacharya
6. Costing. Mr. Babatosh Banerji, The word press pvt ltd 1995.
7. Costing - Dr. Jawahar Lal

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Subject Code	Subject Name	Credits
MSE1022	ENTERPRISE RESOURCE PLANNING	04
Module	Detailed content	Hours
1	Fundamentals of ERP Introduction to ERP - Principles of ERP – ERP An Overview – ERP Framework – Benefits of ERP – ERP Related Technology - Business Blue Print – ERP vs Business Process Re-Engineering - Data Warehousing - Data Mining - On-line Analytical Processing (OLAP).	10
2	ERP Implementation ERP Implementation - ERP Tools - ERP Implementation Lifecycle - Implementation Methodology - Hidden Cost Issues – Analysis of cases from five Indian Companies - Vendors, Consultants and Users - Contracts with Vendors, Consultants and Employees - Project Management and Monitoring –	10
3	ERP Architecture and Technologies Languages - Client & Server Architecture – Technology Choices – Internet Direction – Evaluation Framework – Management Information Systems – Decision Support Systems - CRM – CRM Pricing – Chain Safety – Evaluation Framework – Dynamic Models – Process Models –	10
4	ERP Systems and Applications: Basic concepts of Oracle, SAP, Baan and MAXIMO – Comparison – Integration of Different ERP Applications – ERP as Sales Force Automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.	10
5	ERP Modules and Packages Business modules in an ERP Package - Training on various modules of IBCS - ERP Package-Oracle ERP and MAXIMO, including ERP on the NET - Enterprise Integration Applications (EIA) - ERP and E-Commerce – Web Enabling ERP.	10
6	ERP Trends and Issues Enterprises Restructuring Trends – Outsourcing ERP – Economics – ERP Market - ERP-Present and Future – Turbo Charge the ERP System. - Future Directions in ERP – Integration of ERP with SCM, SRM, CRM, PLM and M&A	10

References:

1. Alexis Leon, ERP Demystified, Tata McGraw–Hill Publishing Company limited, New Delhi, 2002
2. Brady, Enterprise Resource Planning, Thomson Learning, 2001
3. S.Sadagopan, ERP: A managerial Perspective, Tata McGraw-Hill publishing company Limited, New Delhi 1999.
4. Jose Antonio Fernandez, The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.
5. Vinod Kumar Crag and N.K.Venkitakrishnan , Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.
6. ERPWARE, ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999.
7. Thomas E Vollmann and Bery Whybark , Manufacturing and Control Systems, Galgothia Publications, 1998.
8. Recent Literatures on Relevant Topics such as Technical Reports, Research Papers, Articles from International & National Technical & Business Journals.

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MSE1023	RESEARCH METHODOLOGY	04
Module	Detailed Content	Hours
1	Fundamentals of Research Methodology Introduction – Meaning of Research – Objectives of Research – Motivation in Research – Types of Research – Research Approaches – Significance of Research – Research Methods vs Methodology – Scope & Limitations of Research - Criteria of Good Research.	10
2	Research Approach Defining Research Problem – What is a research problem – Selecting the problem – Necessity of defining the problem – Literature review – Importance of literature review to define the research problem – Critical literature review – Concluding Remarks of Literature Review.	10
3	Research Design Research design – Meaning of research design – Need– Features of good design – Important concepts relating to research design – Different types – Developing a research plan	10
4	Research Modeling Types of Models - Model building and stages – Design of Questions – Selection of Components – Tangible and Intangible Components - Selection of Parameters or Factors – Data consideration and testing, Heuristic and Simulation modeling.	08
5	Data Collection & Computer Applications Method of data collection – Collection of data- observation method – Interview method –Questionnaire method – Processing and analysis of data – Processing options – Types of analysis – Interpretation of results- Introduction to spreadsheet application - features and functions - Using formulas and functions - Data storing, Features for Statistical data analysis - Generating charts/ graph and other features Use of Internet for advanced search.	12
6	Report Writing Report writing – Types of Report – Research Report, Research Proposal, Synopsis, Dissertation, Thesis its Differentiation - Technical paper – Research Papers – ISBN – ISSN - Impact Factor Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Simple exercises – Oral presentation – Planning – Preparation – Practice – Making presentation – Answering questions - Use of visual aids – Quality & Proper usage – Importance of effective communication - Illustration	10

References:

1. Coley S M and Scheinberg C A, 1990, "Proposal Writing", Newbury Sage Publications.
2. Leedy P D, "Practical Research: Planning and Design", 4th Edition, N W MacMillan Publishing Co.
3. Day R A, "*How to Write and Publish a Scientific Paper*", Cambridge University Press, 1989.
4. Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India)
5. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India)
6. Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi)
7. Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjani M. (2006), Management
8. Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
9. The complete reference Office Xp – Stephan L. Nelson, Gujulia Kelly (TMH)
10. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH)
11. Fundamental Book on computer Applications

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Subject Code	Subject Name	Credits
MSE1024	PROJECT MANAGEMENT	04
Module	Detailed content	Hours
1	Introduction To Project Management: Project: Characteristics, Types, Selection, Economics, Feasibility assessment and Evaluation, Structuring, Organizational and Work Breakdown, Scheduling. Steps in project planning, Life Cycle Costing, Environment appraisal with projects.	08
2	Program Management and Project Evaluation: Project development cycle, Objectives of investment decision making – Technical analysis. Materials and inputs: production technology – product mix – plant capacity – location and site – machinery and equipment – structures and civil works – project charts and layouts. Projects and contracts planning and co-ordination - Project scheduling and monitoring tools and techniques - Project management information systems and documentation - Computer applications in project management.	12
3	Activity Planning and Risk Management: Objective of planning, Project schedule, sequencing and scheduling, development of project network, time estimation. Portfolio theory and capital asset pricing model approaches to risk analysis – Network techniques for project management – PERT, CPM.	10
4	Managing People and organizing teams: Management spectrum, associating human resource with job, motivation decision making, leadership, stress health and safety.	08
5	Project financing : Costing - Financial and economic appraisal of single project – multiple projects, Project cash flows –Investment criteria- Net Present Value-Cost Benefit Ratio and analysis-Internal Rate of Return - Payback period –Accounting Rate of Return. Source of finance - Cost of capital - Capital structure. UNIDO, World Bank and OECD methodologies.	12
6	Project Approach and Software Efforts Estimation: Introduction to Software Project Management (SPM) - Software Metrics – Software quality –Risk management in SPM- Emerging issues. Computer Supports; MS Project / Primavera Software Application and Use	10

References:

1. Prasanna Chandra, 'Projects Planning, analysis, Financing, Implementation and ReviewManagement', V Edition Tata McGraw Hill, 2004.
2. Wysocki 'Effective Project Management W/Cd' John Wiley 2nd edition 2000
3. Choudhury, S., 'Project management', Tata McGraw Hill, 27th reprint 2007.
4. Narendra Singh, Project Management and Control, Himalaya Publishing House
5. Benington Lawrence - Project Management, McGraw Hill
6. Project Management, David I. Cleland, Mc Graw Hill(1999)
7. MS Project, Microsoft Network
8. Primavera Manual

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Subject Code	Subject /Lab Name	Credits
MSL101	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	01
Module	Detailed content	Lab. Sessions
1	Operation, Control and Programming of various computer controlled machines in the FMS such as CNC machine tools, Automated Storage/Retrieval (AS/RS) systems, Robots, automated assembly station etc Or Any one from the above and Case study presentation on Simulation and performance analysis of the FMS, parts flow control on Assembly station.	09
2	Study experiments on Integration aspects in computer integrated manufacturing environment, Importance of Artificial Intelligence.	06

Note:

With reference to the case study based experiments/presentations on the above topics;

It is desirable to have innovations. Repetition of case studies should be avoided.

May be prepared from recent journal papers, books or actual visit to any Automated (Fully or partially) Manufacturing Industry.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject/Lab Name	Credits
MSL102	QUALITY & RELIABILITY ENGINEERING	01
Module	Detailed content	Lab. Sessions
1	Using live data from separate case studies and complete analysis of following topics (minimum three). Every student is expected to do individual and different three case studies from the above syllabus preferably FMEA,QFD,DOE	05
2	Use modern software like SPSS, / Minitab etc for complete analysis of data from experimentation or a Field / online survey questionnaire. One full report may be submitted mentioning all its objectives, methodologies, inferences etc.	05
3	Assignments from the above syllabus and not covered in 1 and 2	--

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
MSC201	SUSTAINABLE MANUFACTURING	04
Module	Detailed content	Hours
1	Sustainability: Concepts related to Sustainability, Ecosystems, Biodiversity, Air and water pollution, Energy consumption, Land degradation, Global warming, Sustainable Development, The global sustainability Agenda, Green Expectations, Confronting climatic change, Wake-up Conferences, The Voice of Society, Answering the call- The Green Movement	06
2	Types and sources of solid and hazardous wastes: nature and hazard of pollutants: waste processing /segregation Need for waste management, Waste processing, Green processing and engineering operations, incineration, Energy recovery, a life-cycle approach, which considers the costs and benefits associated with material acquisition, transportation, production, product use, and recovery for recycling, reuse or remanufacture. Inventory management and improved operations.	10
3	Environment friendly choices in manufacturing, operations and logistics: Materials for Sustainability, Materials and processes selection, Materials for the future, Materials for Recycling, Control on non-renewable material usage Component toxicity and health impact, Integrating sustainability principles,	12
4	Conversion technologies, Innovations for reuse, bio processing technology Energy audits, Sustainable loading on ecosystems, The concept of "eco-efficiency," a measurable characteristic of products and processes, Product Life Cycle Assessment: Environmental analysis from raw materials to disposal, Metrics for sustainable design ,industrial case studies.	12
5	Overview of the cultural, political, and economic changes that are transforming the role of environmental management in the business world. Environmental Standards e.g. ISO- 14000 Environmental Legislations: Carbon Foot Print, Implications of public policy, Anti-pollution Boards Guarding Against Environmental Impact, Alternative product and process changes, manufacturing practices, Global warming and Kyoto protocol, environmental preservations. Environment and human health, Access to potable water	10
6	Multi-objective Decision Making: Considering environmental issues in operating strategy, Creating a sustainable manufacturing company Effective Hazards Mitigation Management, Role of IT, Communication Networking, Continuous sustainability awareness programmers; Encouraging innovations in energy generation and usage economy, Sustainability Rating Schemes, Eco-labeling Programs Case Studies, human values and professional ethics	10

References:

1. Sustainable Development by M. K. Ghosh Roy; Ane Books Pvt. Ltd.
2. Green Management by M. Karpagam, Geetha Jaikumar; Ane Books Pvt. Ltd
3. Essential Environmental Studies, S. P. Misra, S.N. Pandey, Sheth Publishers
4. Design for Environment: A Guide to Sustainable Product Development, Joseph Fiksel, The McGraw-Hill Companies

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Subject Code	Subject Name	Credits
MSC202	MECHATRONICS & INDUSTRIAL AUTOMATION	04
Module	Detailed content	Hrs.
1	Introduction to Mechatronics 1.1 What is Mechatronics 1.2 Measurement systems and Control Systems 1.3 Examples of application of the Mechatronics approach. 1.4 Signal Conditioning; Data Presentation and Data Acquisition systems (Treatment of this topic may be limited to understanding the concepts involved, without detailed analysis of circuits)	06
2	Sensors and Transducers 2.1 Performance Terminology 2.2 Displacement, position and Proximity Sensors 2.3 Velocity and Motion Sensors 2.4 Force and Fluid Pressure Sensors 2.5 Liquid level and Flow sensors 2.6 temperature and light Sensors. 2.7 Selection of Sensors	10
3	Digital Logic; Microprocessors; Microcontrollers and Programmable Logic Controllers 3.1 Digital logic 3.1.1 Number systems 3.1.2 Logic Gates 3.1.3 Boolean Algebra 3.1.4 Simplification of Boolean equations using Karnaugh Maps. 3.2 Microprocessors and Microcontrollers (Only basic understanding and applications) 3.2.1 Concept of Microprocessor based control and its application 3.2.2 Parts of a Microprocessor system with block diagram of the general form of a microprocessor system. Data bus, Address bus and Control Bus. 3.2.3 General internal Architecture of a Microprocessor. Functions of constituent parts such as ALU, Various Registers and the Control unit. 3.2.4 Difference between a Microprocessor and a Microcontroller. General Block diagram of Microcontroller. 3.2.5 Assembly language programming. (Only simple programs as examples)	10

4	<p>Control Theory</p> <p>4.1 Basic system modeling</p> <p>4.1.1 Elements in Control Systems; Concept of Open loop and Closed loop systems</p> <p>4.1.2 Mathematical Models of Mechanical-translational; Mechanical-rotational And Electrical systems and obtaining their Transfer functions</p> <p>4.1.3 Block diagrams. Reduction</p> <p>4.2 Time and Frequency response</p> <p>4.2.1 Time domain specifications; Response of First and Second Order systems; steady state Error.</p> <p>4.2.2 Frequency domain specifications: Bode Plot: Method and stability analysis using Gain and Phase Margins obtained from it. Polar Plot (basic concept)</p> <p>4.3 Stability Analysis</p> <p>4.3.1 Characteristic equation-location of roots in S plane for stability; Routh Hurwitz criterion; Root locus technique and construction.</p> <p>4.4 Closed Loop Controllers</p> <p>4.4.1 Continuous and Discrete Processes</p> <p>4.4.2 Control Modes: Two step mode; Proportional Mode; Derivative Mode; Integral Mode and combination mode (only basic concept; no circuits)</p>	12
5	<p>Mechanical and Electrical Actuators</p> <p>5.1 Review of Mechanical Actuators.</p> <p>5.2 Electrical Systems</p> <p>5.2.1 Mechanical switches; Solid state switches and Solenoids</p> <p>5.2.2 D.C. Motors, A.C. Motors, Stepper Motors</p>	10
6	<p>Pneumatic and Hydraulic actuation systems</p> <p>6.1 Understanding the concept of Low Cost Automation.</p> <p>6.2 Pneumatic Control</p> <p>6.2.1 Different types of valves and Actuators in Pneumatics, their applications and use of their ISO symbols.</p> <p>6.2.2 Design of Pneumatic circuits using Cascade method and Shift Register Method. (up to 3 cylinders)</p> <p>6.2.3 Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping.</p> <p>6.2.4 Design of Pneumatic circuits using PLC Control (ladder programming only). Upto 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.</p> <p>6.3 Hydraulic Control</p> <p>6.3.1 Different types of valves and Actuators in Hydraulics, their applications and use of their ISO symbols.</p> <p>6.3.2 Meter in, meter out and Bleed off circuits. Sequencing circuits.</p> <p>6.3.3 Accumulators and their types. Applications of Accumulator circuits.</p> <p>6.3.4 Problems based on sizing and selection of Hydraulic components.</p> <p>6.3.5 Actuation technology in Hydraulic valves: Proportional and Servo Hydraulics and Digital Hydraulics. Design of Electro- Hydraulic circuits</p>	12

References:

1. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering; Pearson Education
2. Mechatronics ", Edited by HMT ,Bangalore 1998
3. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988
4. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979
5. Joji P., Pneumatic Controls ; Wiley India
6. K.Ogata, modern controls engineering “ Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
7. B.C. kuo, “Automatic Control Systems”, Prentice Hall of India Pvt. Ltd., New Delhi, 2004
8. I.J.Nagrath and Gopal. “Control system engineering”, new age international (P) Ltd., 2006.
9. Jacqueline Wilkie; Michael Johnson; reza, Control Engineering an introductory course: Palgrave (Indian reprint by Replika Press Ltd) 2009

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Subject Code	Subject Name	Credits
MSC203	ADVANCE QUANTITATIVE TECHNIQUES	04
Module	Detailed content	Hours
1	Decision environment, Decision making process; Optimization, search problems, Heuristics, deterministic and probabilistic situations, single and multiple persons making, Introduction to related software's	04
2	Linear programming problems(LPP) 2.1 Methods to solve linear programming problems 2.2 Advance Topics in linear programming problems 2.2.1 Sensitivity analysis 2.2.2 Revised Simplex Method 2.2.3 Goal programming 2.2.4 Parametric Linear programming 2.2.5 Integer Linear programming , 2.2.6 Decomposition Method	16
3	Introduction Non linear programming problems (NLLP) 3.1 Unconstrained Non linear Algorithm Search and Gradient method 3.2: Constrained Non linear Algorithm, 3.2.1 Geometric Programming, 3.2.2 Separable Programming 3.2.3 Quadratic programming, 3.2.4 Stochastic Programming	12
4	Dynamic (Multistage) programming and its applications in various fields	08
5	Decision Theory 5.1 Decision under risk 5.2 Decision under uncertainty: 5.3 Decision tree for decision making, Bayesian approach in decision making	10
6	6.1 Queuing Theory 6.2 Monte Carlo simulation	10

References:

- 1 Ravindran A. Philips D.T and Solbetrg J.J. Operation Research: Principles Practices, John Wiley, 2nd Ed.
- 2 Bazzarra M S Jarvis J.J and Sherali H.D: Linear Programming and Network 2nd ED; John Wiley
- 3 Winston W.L Operation Research: Application and Algorithm, Kent P.W. S 2nd Ed.
- 4 Taha H.A. Operation Research: An Introduction, Macmillian
- 5 Kapoor R. Computer assisted decision models Tata McGraw Hill
- 6 B Banerjee: Operation Research Techniques for Management, Business Book Publishing House.

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Subject Code	Subject Name	Credits
MSE2031	WORLD CLASS MANUFACTURING	04
Module	Detailed content	Hours
1	World-Class Manufacturing (WCM): Manufacturing Excellence and Competitiveness, Meaning of World-class, Competing in World markets, WCM Techniques, Review of frameworks for WCM, Justification of WCM	06
2	An overview of Manufacturing Strategy: Manufacturing strategy concepts and domains. Incorporating manufacturing perspective in corporate Strategy, Trade-offs in manufacturing objectives. Creating competitive advantages through manufacturing strategy. Competitiveness models. The process of manufacturing strategy formulation and implementation, Manufacturing strategy – examples from the industry (Indian and international context).	10
3	Introduction to Lean Manufacturing: Elements of Lean manufacturing : Stability, Standardized work, Just in time, Jidoka, Hoshin Planning, The culture of lean, Implementation of Lean manufacturing : Implementation framework for the Lean manufacturing, Case Study	12
4	Total Productive Maintenance (TPM) : An overview of various maintenance systems, Evolution of TPM, Productivity and TPM, OEE, TPM and TQC, Small Group Activities, Pillars of TQM, Kobetsu-Kaizen (Continuous Improvement), Jishu-Hozen (Autonomous maintenance), Planned Maintenance System, Skill upgrade training, Initial control (Equipment Life cycle management), Hinshitsu-Hozen (Quality Maintenance), Office TPM, Total safety management, Implementation, 5s, Case Study	12
5	Total Quality Management (TQM) : Definition, Understanding quality, Evolution of TQM, Framework for TQM, Commitment and leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance measures, Formulation and implementation of TQM, Case Study	10
6	Other features of WCM : Supply Chain Management & key issues in SCM, Role of Information system in WCM, Knowledge management - Introduction, Benefits, Tools and techniques, Study of various performance measures in world class organization, Human Resource Dimensions in WCM	10

References:

1. Jim Todd, "World-class Manufacturing", McGraw Hill, London, 1995
2. Schonberger R.J., "World Class Manufacturing - The Lesson of Simplicity", Free Press, 1986
3. Marcus, A A., Management strategy: achieving sustained competitive advantage, New York : McGraw-Hill/Irwin, 2011.
4. Voss C.A., "Manufacturing Strategy: Process and Content", Chapman & Hall, London, 1992.
5. Pascal, D., "Lean production simplified", 2nd Edition, Productivity Press, 2007
6. Nakajima, S., "Introduction to Total Productive Maintenance", Productivity Press, 1988.
7. Besterfield D. H., et al., "Total Quality Management", Pearson Education, 1999.
8. Mohanty R.P. and Deshmukh S.G., "Advanced Operations Management", Pearson Education, 2003.

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Subject Code	Subject Name	Credits
MSE2032	PRODUCT LIFECYCLE MANAGEMENT[@]	04
Module	Detailed content	Hours
1	<p>Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM</p>	10
2	<p>Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process</p>	12
3	<p>Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation. Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies</p>	12
4	<p>Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design.</p>	10
5	<p>Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis</p>	08
6	<p>Technology Forecasting: Evolution for technology forecasting and its importance, Future mapping, Methods of technology forecasting such as Relevance Trees, Morphological Methods and Mission Flow Diagram, Combining forecast of different technologies</p>	08

@ Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Manufacturing Systems Engineering

References:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

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Subject Code	Subject Name	Credits
MSE2033	LOGISTICS & SUPPLY CHAIN MANAGEMENT	04
Module	Detailed content	Hours
1	Introduction: Understanding Supply Chain, Historical developments in supply chain management, issues in SCM, linkages within the value chain, strategic Supply Chain Management (SCM) decision phases, Scope of Logistics, philosophy and concept work of logistics, logistics & competitive strategy.	06
2	Supply Chain performance: Customer driven strategies in production & distribution systems, customer focus in SCM, management of supply sources, Drivers & obstacles. Measuring logistics costs & performance	10
3	Planning Demand & Supply in SC: Demand forecasting, Aggregate Planning, Planning & managing inventories in SC, Distribution network designs factors influencing network designs, distribution networks in practice frame work for network design decision. Network design in uncertain environment.	12
4	Supply Chain Planning: Transportation in SC, Coordinating SC, Integrated production & distribution networks, source decision in SC. Network Design &IT in SC, SCM in the context of JIT, Total Quality Control and product innovation across the supply chain. Metrics for measurement of supply chain performance. Mathematical programming and other models for supply chain decisions. Measuring Logistics costs & performance.	14
5	IT enabled SC, Best practices & benchmarking for SC, towards Green SC, towards World class SCM, Role of IT in Logistics management.	10
6	Leading edge logistics, IT application in freight logistics, Case studies from the literature & practice. Basic familiarity with mathematical modeling & optimization.	10

References:

- 1 Sunil Chopra, P. Meindl, Supply Chain Management, Pearson Education Asia.
- 2 R.P. Mohanty, S.G. Deshmukh, Essentials of Supply Chain management, Phoenix publishing House Pvt Ltd.
- 3 Martin Christopher, Logistics and Supply Chain Management, Pitman Publishing.
- 4 Bowon Kim, Mastering Business in Asia. Supply Chain Management, John Wiley & sons (Asia) Pte Ltd.
- 5 M.G. Korgoankar, Just in Time Manufacturing, The Free Press.
- 6 S.K. Bhattacharya , Logistics Management, Pearson Publication

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Subject Code	Subject Name	Credits
MSE2034	MICRO ELECTRO MECHANICAL SYSTEMS[®]	04

Module	Detailed content	Hours
1	Introduction to MEMS & Applications <ul style="list-style-type: none"> • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators. 	06
2	Sensors and Actuators in Micro-domain <ul style="list-style-type: none"> • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors, Chemical Sensors • Sensors & Actuators for Automotive, Biomedical, Industrial applications • Design of sensor and actuator for few applications such as automobile accelerometer, bimetallic temperature sensor, etc. 	12
3	Fabrication Methods Microfabrication Methods (VLSI Techniques) <ul style="list-style-type: none"> • Positive and Negative Photoresists, • Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques. 3D High Aspect Ratio Techniques <ul style="list-style-type: none"> • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc. 	10
4	Modelling and Simulation Techniques <ul style="list-style-type: none"> • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis • Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling • Modelling of Micro-channel as heat exchanger, accelerometers, micro-hinges, compound microstructures. • Linear & Nonlinear Model. • Numerical Methods used for MEMS analysis. 	10

5	<p>Characterization Techniques Topography Methods (Optical, Electrical and Mechanical Methods)</p> <ul style="list-style-type: none"> • Microscopy, STM (Scanning Tunneling Microscopes), SEM (Scanning Electron Microscopes), SPM (Scanning Probe Microscopes), AFM (Atomic Force Microscopes) <p>Mechanical Structure Analysis</p> <ul style="list-style-type: none"> • Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric) • Interferometry Techniques, SPI (Speckle Pattern Interferometry), ESPI (Electronic Speckle Pattern Interferometry), • Laser Techniques, Laser Doppler Vibro-meters <p>Fluid, Thermal and Chemical Analysis</p> <ul style="list-style-type: none"> • Thermal Analysis Techniques (Theoretical and Experimental), Fluid Flow Pattern Analysis, Electro-chemical Analysis, • PIV Techniques • Spectroscopy 	12
6	<p>Introduction to Advances of MEMS and Nanotechnology</p> <ul style="list-style-type: none"> • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Nano-tribology, & nano-indentation techniques, • Domestic and Industrial Applications of nanotechnology • Molecular Modelling Techniques. • Social and Ethical Implications of nanotechnology in Society 	10

@ Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Manufacturing Systems Engineering

References:

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

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
MSE2041	BUSINESS INTELLIGENCE	04
Module	Detailed content	Hrs.
01	Business Intelligence overview: historical review - Study of Information Technology resources such as database systems, enterprise systems, and networks explained in their role of supporting decision makers. Special attention given to hands-on-experience in team projects for developing and using Business Intelligence. Ethical, legal, and behavioral issues of conducting Business Intelligence	08
02	Knowledge Management: Collaborative Business Intelligence: Integrating BI and KM, Taking lessons from KM to influence business intelligence, Data quality, Technological Support for Strategic Management in the Knowledge Based Economy, People centric BI and KM: Relationship and Integration of KM Content , KM as an Intelligence Tool using MS office/ MS sharepoint /SAP	10
03	Capture the business and technical requirements for Business Intelligence solution architecture. • The stages and requirements of a Business Intelligence project lifecycle. Implementation of a Business Intelligence development project. • Assess and design a Business Intelligence infrastructure. • Describe and plan Business Intelligence operations and their management. Managing Data Archiving. Planning and implementing data archiving in a BI solution.	08
04	Planning a Business Intelligence Project • Determining Business Intelligence Requirements • Revising and Updating a Business Intelligence. Intelligence development requirements and implement a Business Intelligence development project. • Manage a Business Intelligence development project. • Determine effective data management processes	10
05	Designing Business Intelligence Infrastructure How to identify infrastructure requirements for a Business Intelligence solution, and how to design an effective infrastructure to provide the required levels of scalability and availability. • Evaluating Software Requirements Managing Business Intelligence Operations Overview of Business Intelligence Operations • Managing Maintenance and Operations Tasks • Managing Data Archiving • Planning the Operations Solution • Evaluating Operational Costs and Risks	14
06	The online analytical processing (OLAP), extract, transport, Data Migration and ETL (Extract, Transform, and Load), and reporting technologies. Foundational understanding of Web-based architecture	10

References:

- 1 Bill Inmon: Building the Data Warehouse. (4Th Ed.) books.google.co.in – 2005
- 2 Galit Shmueli, Nitin R. Patel and Peter C. Bruce- Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner, Wiley, 2007.
- 3 William H. Inmon, Bonnie K. O'Neil, Lowell Fryman: Business metadata: capturing enterprise knowledge : books.google.co.in – 2008
- 4 Kimball's Data Warehouse Toolkit Classics: The Data Warehouse Toolkit, 2nd Edition; The Data Warehouse Lifecycle Toolkit, 2nd Edition; The Data Warehouse ETL Toolkit John Wiley & Sons, 2009.
- 5 Sid Adelman, Larissa Terpeluk Moss: Data warehouse project management, Volume 1, Addison-Wesley, 2000

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Subject Code	Subject Name	Credits
MSE2042	MANUFACTURING STRATEGY	04
Module	Detailed content	Hours
1	Introduction to manufacturing strategy and links with corporate strategy Need for manufacturing strategy (MS) and concept of MS	08
2	Process of MS formulation and implementation Emerging theory of manufacturing ,Beyond world class: The new manufacturing strategy, Time the new source of competitive strategy, Competing through manufacturing, What strategy can do for technology	08
3	Focus of MS decisions relating to capability, flexibility, product variety, inventory, supplier relationships, manufacturable design <ul style="list-style-type: none"> • Plan for economies of scope • What really makes factories flexible • Cummins engine flexes its factory • Dedicated assets: Japan's manufacturing edge • Organizing for manufacturable design • Manufacturing by design • New product development map. 	08
4	Role of Quality in the framework of MS-TQM, SPC, 6-sigma Competing on eight dimensions of quality. Interface of marketing and manufacturing Can marketing and manufacturing co-exist?	12
5	Manufacturing Outputs: Manufacturing systems & challenges to meet manufacturing outputs such as (Cost, Quality, Design Performance, Delivery, Flexibility, Innovations)	08
6	Manufacturing strategy in business success, Drivers and influencers of sustainable systems Structured strategy formulation. Approaches to strategy formulation in different business contexts Ingredients for a world-class manufacturing strategy <ul style="list-style-type: none"> • JIT production controlled by Kanban • Another look at how Toyota integrates product development • Beyond vertical integration Insights in to the Indian manufacturing scenario: Contemporary topics from Indian manufacturing	16

References:

- 1) Manufacturing Strategy by John Miltenburg Publisher: Productivity Press; 2 edition (March 9, 2005)
- 2) Manufacturing Strategy by Terry Hill Publisher: McGraw-Hill/Irwin; 3 edition (December 13, 1999)
- 3) Manufacturing in the Corporate Strategy (New York: John Wiley & Sons, 1978). Wickham Skinner

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Subject Code	Subject Name	Credits
MSE2043	ENTREPRENEURSHIP DEVELOPMENT	04
Module	Detailed content	Hrs.
1	I. Introduction: The concept of Entrepreneur & entrepreneurship. Characteristic and qualities of entrepreneur, types & functions of entrepreneur. Factors affecting entrepreneurial growth. II. Business Opportunities, Sources of business or product ideas, identifying business opportunities & steps involved in identification.	08
2	III. Market Survey & Techno-feasibility: Purpose/ objective, Techniques, Market research & limitations, Project formulation, Guidelines/steps, Preparation of Project report, Techno-commercial feasibility studies, contents & preparation of feasibility report. IV. Product identification & selection, Criteria for product selection, Barriers.	10
3	V. Technology: Selection of technology, Selection of plant and equipment. VI. Finance Resource Generation: Various financial Institutions, Formalities and procedures involved in loan procurement. VII. Finance Management: Process of book-keeping & accounting, Books of accounts, Trial balance, Financial statements and funds flow, Financial Ratio, Significance & analysis	12
4	VIII. Energy Sources: Classification, identification & Selection, Conservation of energy & Management, IX. Product & Market Strategy, Packaging, advertising, X. Costing & Pricing: Elements of cost, pricing and methods	10
5	XI. Safety: Industrial safety, Techniques, Regulation & upkeep of man & machine safety. Safe practice, Safety regulation XII. Industrial Registration & License: Industrial act- Objectives, scope & provisions of act. XIII. Other Related Acts: Factory act, Partnership act, Industrial Employments act, Sale of goods Act	10
6	XIV. Taxation: Income tax, Sales Tax & Excise duty. XV. Social Responsibility & Business Ethics: Definition, Evolution Implication and application of esthetics to business.	10

References:

1. David H. Holt 'Entrepreneurship: New Venture Creation'.
2. Hisrich, 'Entrepreneurship', Tata McGraw Hill, New Delhi, 2001.
3. P.C.Jain (ed.), 'Handbook for New Entrepreneurs', EDII, Oxford University Press, 1) New Delhi, 1999.
4. A. C. Fernando' Business Ethics: An Indian Perspective' by Pearson Education India
5. Vasant Desai, Entrepreneurship-principles and practices, Thomson publications.
6. P.C. Jain – Handbook for New Entrepreneurs
7. Poornima Charantimath' Entrepreneurship Development-Small Business Enterprise', 2) Pearson Education, 2007

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Subject Code	Subject Name	Credits
MSE2044	MICRO & NANO MANUFACTURING SYSTEM	04
Module	Detailed content	Hours
1	Scope of Nano Technology: Nano technology Concepts and Applications Micro- and Nanofabrication, Nano technology in India Scope for Microfabrication, Rise Nano technology Fields Commercialization Issues of Micro-Nano Technology	06
2	Microfabrication: Mechanical Micromachining, Physical Fabrication Methods, Lithography, Processing Setup, Nano Lithography & Manipulation, Precision Micro- and Nanogrinding , Use of Spectrometers & Microscopes	10
3	Laser-Based Micro- and Nanofabrication Pulsed Water Drop Micromachining, Nano Materials, Synthesis of Nano materials, Bio Materials, Nano Composites, Development of Nano Particles	12
4	Innovative Applications on Present Devices: Nanochips, Nanotubes and Nanowires, Integation of chips and microprocessors, Technology Support, Meeting Social Needs	12
5	Nano Design & CAD: Computer Aided Nano Design, VLSI product detailing Finite Element Analysis of Microstructures, 3-D Molecular Modelling	10
6	Acceptability of Nano Workmanship: Nano to millimeter Integration Atomic Scale Precision & Control, Promising Nano-centered Future	10

References:

1. Microfabrication & Nanomanufacturing by Mark J. Jackson
2. ASM handbook on machining

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject/Lab Name	Credits
MSL203	MECHATRONICS AND AUTOMATION	01

Module	Detailed content	Lab. Sessions
1	Simulation of basic hydraulic, pneumatic and electric and combination circuits using software like automation studio---etc	05
2	Design and Testing of hydraulic. Pneumatic, electropneumatic and PLC circuits.	05
3	Live case studies on <ul style="list-style-type: none"> • Industrial hydraulic, pneumatic, electropneumatic and PLC circuits • Low cost automation Techniques • Microprocessor based controls 	05

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject/Lab. Name	Credits
MSL204	ADVANCED QUANTITATIVE TECHNIQUES	01

Module	Detailed content	Lab. Sessions
1	Exercices on LPP Softwares , AHP Software's & others.	05
2	Exposure to other OR & Simulation softwares.	05
3	Live case studies / Assignments.	05

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
MSS301	Seminar	03

Guidelines for Seminar

- Seminar should be based on thrust areas in Mechanical Engineering
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures (at least 10 papers from Refereed Journals) and understand the topic and compile the report in standard format and present in front of Panel of Examiners (pair of Internal and External examiners appointed by the University of Mumbai).
- **Seminar should be assessed based on following points**
 - Quality of Literature survey and Novelty in the topic
 - Relevance to the specialization
 - Understanding of the topic
 - Quality of Written and Oral Presentation

NOTE :

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.
2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.
3. At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Subject Code	Subject Name	Credits
MSD301 / MSD401	Dissertation (I and II)	12 + 15

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
 - Quality of Literature survey and Novelty in the problem
 - Clarity of Problemdefinition and Feasibility of problem solution
 - Relevance to the specialization
 - Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
 - Quality of Literature survey and Novelty in the problem
 - Clarity of Problemdefinition and Feasibility of problem solution
 - Relevance to the specialization or current Research / Industrial trends
 - Clarity of objective and scope
 - Quality of work attempted
 - Validation of results
 - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai
- Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)