UNIVERSITY OF PUNE

Structure and Syllabus

FOR

M.E. Mechanical Engineering
(COMPUTER AIDED DESIGN, MANUFACTURE & ENGINEERING)
2013-Course

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM July 2013

M.E. Mechanical Engineering (Computer Aided Design, Manufacture & Engineering)

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
507201	Advanced Mathematics	4	50	50	-	-	100	4
502402	Advanced Machine Design	4	50	50	-	-	100	4
502403	Computer Aided Design	4	50	50	-	-	100	4
502404	Research Methodology	4	50	50	-	-	100	4
502405	Elective I	5	50	50	-	-	100	5
502406	Modelling and Analysis Lab	4			50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

SEMESTER II

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./ Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
502407	Computer Integrated Manufacturing	4	50	50	-	-	100	4
502408	Industrial Product Design & Product Life Cycle Management	4	50	50	-	-	100	4
502409	Automated Manufacturing System Modelling	4	50	50	-	-	100	4
502410	Elective II	5	50	50	-	-	100	5
502411	Simulation Lab	4	-	-	50	50	100	4
502412	Seminar I	4	-	-	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Elective I: Common to All M.E. Mechanical Programmes**

SEMESTER III

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
602413	Simulation Modelling	4	50	50	-	-	100	4
602414	Optimization Techniques	4	50	50	-	-	100	4
602415	Elective III	5	50	50	-	-	100	5
602416	Seminar II	4	-	-	50	50	100	4
602417	Project Stage I	8	-	-	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

SEMESTER IV

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME				CREDITS
		Lect. / Pr	Paper	TW	Oral/ Presentation	Total	
602418	Seminar III	5	-	50	50	100	5
602419	Project Work Stage II	20	-	150	50	200	20
Total		**25**	**-**	**200**	**100**	**300**	**25**

Lab Practice I & II:

The laboratory work will be based on completion of assignments confined to the courses of that semester.

SEMINAR:

The student shall deliver the seminar on a topic approved by authorities.

Seminar I: shall be on state of the art topic of student's own choice approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar II: shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar III: shall be extension of **seminar II.** The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

PROJECT WORK:

The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project Work Stage – I

Project work Stage – I is the integral part of the project Work. In this, the student shall complete the partial work of the Project that will consist of problem statement, literature review, project overview, scheme of implementation (UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. The candidate shall deliver a presentation as a part of the progress report of Project work Stage-I, on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the progress report of Project work Stage-I in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Project Work Stage - II

In Project Work Stage – II, the student shall complete the balance part of the Project that will consist of fabrication of set up required for the project, conducting experiments and taking results, analysis & validation of results and conclusions.

The student shall prepare the final report of Project work in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Note: Institute must submit the list of candidates, guide and project details (title, area, problem definition, and abstract - clearly indicating objectives and scope, sponsorship details, if any) to the university within month of commencement of third semester. The guide must be approved/qualified teacher of the institute. A guide can guide at the most 8 students per year.

Semester – I

Advanced Mathematics [507201]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
507201	4	50	50	-	-	100	4

1. **Inner Product Spaces, Orthogonality**
   Inner products, Cauchy-Schwartz inequality, Orthogonal projections, Gram-Schmidt orthogonalization, Matrix representation of inner product, Least square solutions

2. **Complex Analysis**
   Complex variables, Complex differentiation, Harmonic functions, conformal mapping, Complex Integration, Cauchy's integral formulae and Calculus of residues

3. **Transforms**
   Concept of transforms, Fourier transforms, Applications to partial differential equations, Discrete Fourier transform, Laplace transforms and its inverse, Laplace transform of special functions: Unit step, Unit impulse, Periodic and Error. Applications to initial value problem and wave equation using transform techniques.

4. **Differential Equation**
   Series Solution of differential equations, Bessel's and Legendre's differential equations, Mass spring systems of multi degree freedom, Matrix formulation for differential equations in vibration theory, Normal mode solution, Numerical computation of Eigen value.

5. **Numerical Analysis**
   Finite difference analysis, Explicit and Implicit finite difference scheme, Stability of finite difference method, Applications of finite difference analysis in boundary value problems, one dimensional diffusion equation, Wave equation, Laplace equation.

6. **Calculus of Variation**
   Introduction, Functional, Euler's equation, Isoperimetric Problem, Functional involving higher order derivative, Approximate solution of boundary value problem, Rayleigh –Ritz method , Galerkin's method, Lagrange's principal.

Reference Books

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers Delhi
3. Linear Algebra, Jin Ho Kwak and Sungpyo Hong, Springer international edition
4. Mechanical Vibration, Singiresu S. Rao, Pearson Education, Inc
5. Applied Numerical Analysis, Curtis F.Gerald and Patrick O. Wheatley, Pearson Education, Inc
6. Essential Mathematical Methods for Physicists, Hans J. Weber and G. B. Arfken, Academic Press

Semester – I

Advanced Machine Design [502402]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502402	4	50	50	-	-	100	4

1. Theory of Elasticity

State of stress at a point, stress components on an arbitrary plane, principal stresses, plane stress, differential equations of equilibrium, boundary conditions. State of strain at a point, plane strain, compatibility conditions, generalized Hooke's Law, relations between elastic constants, displacement equations of equilibrium. Elasticity problems in two dimension and three Dimensions, Airy's Stress Function In Rectangular & Polar Coordinates.

2. Theories of Failure:

Maximum principal stress theory, maximum shear stress theory, maximum elastic strain theory, octahedral shearing stress theory, distortion energy theory, Mohr's theory, significance of theory of failure.

3. Energy Methods

Elastic strain energy, strain energy due to axial force, shear force, torsion, bending moment, Castigliano's theorems, theory of virtual work and energy, Raleigh-Ritz method and Galerkin's method.

4. Design For Fatigue, Brittle Fracture And Creep

Introduction, Fatigue strength, factors affecting fatigue behaviour, Influence of super imposed static stress, Cumulative fatigue damage, fatigue under complex stresses, Fatigue strength after over stresses, True stress and true strength. Design for brittle fracture. Mechanism of creep of material at high temperature, Exponential creep law, hyperbolic sine creep law, stress relaxation, bending etc

5. Composite Materials

Composite materials and structures, classical lamination theory, elastic stress analysis of composite material, Fatigue strength improvement techniques, stresses, stress concentration around cut outs in composite laminates, stability of composite laminate plates and shells, Hybrid materials, applications

6. Design Of Mechanical Components

a) Gear Design: - Involute gears, tooth thickness, interference, undercutting, rack shift etc. Profile modification, S and So spur, helical gears etc.

b) Spring Design: - Vibration and surging of helical springs, helical springs for maximum space efficiency, analysis of Belleville springs, ring spring, volute spring & rubber springs. Design for spring suspension.

Reference Books

1. L S Srinath, **Advanced Solid Mechanics**, Tata McGraw-Hill.
2. S P Timoshenko, J N Goodier, **Theory of Elasticity (Third Edition)**, McGraw-Hill.
3. M.F. Spotts & T.E. Shoup, **Design of Machine Elements**, Pearson Education.
4. Joseph E. Shigley & Chales R. Mischke **Mechanical Engineering Design**, McGraw Hill
5. George B. Dieter, **Engineering Design**, McGraw Hill.

6. Arhur H. Burr & John B. Chetham, **Mechanical Analysis & Design**, Prentice Hall India.
7. Robert C. Juvinall & Kurt, M. Marshel, **Fundamentals of Machine Component Design,** John Wiley & Sons.
8. Robert L. Norton, **Machine Design, An Integrated Approach**, Pearson Education
9. M. F. Spotts, **Mechanical Design Analysis,** Prentice-Hall.
10. A.M. Wahl, **Mechanical Springs**, McGraw-Hill Inc.
11. D. Hull and T.W. Clyne, **An Introduction to Composite Materials,** Cambridge Solid State Science Series
12. D. W. Dudley, **Handbook of Practical Gear Design**, Mc Graw-Hill Book Co.

Semester – I
Computer Aided Design [502403]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502403	4	50	50	-	-	100	4

1. CAD Tools

Definition of CAD Tools, Types of system, CAD/CAM system evaluation Criteria, Graphics standards, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software.

Wire frame modeling -Types of mathematical representation of curves, wire frame models, wire frame entities, parametric representation of synthetic curves - Hermite cubic splines, Bezier curves, B-Splines, rational curves - NURBS.

2. Surface Modeling

Mathematical representation of surfaces, Surface model, Surface entities, surface representation, Parametric representation of surfaces, plane surface, ruled surface, surface of revolution, Tabulated surface.

3. Parametric Representation Of Synthetic Surfaces

Hermite Bicubic surface, Bezier surface, B-Spline surface, COONs surface, Blending surface, Sculptured surface, Surface manipulation - Displaying, Segmentation, Trimming, Intersection, Transformations - 2D and 3D, Orthogonal and Perspective transformations.

4. Solid Modeling

Solid Representation - Boundary Representation (B-rep), Constructive Solid Geometry (CSG) and other methods, Design Applications: Mechanical tolerances, Mass property calculations, CAD database structure.

CAD/CAM Data Exchange: Evaluation of data- exchange formats, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF.

5. Advanced Modeling Concepts:

Feature Based Modeling, Assembly Modeling, Behavioral Modeling, Conceptual Design & Top-down Design. Techniques for visual realism - hidden line - Surface removal - Algorithms for shading and Rendering. Parametric and variational modeling, Feature recognition, Design by features, Assembly and Tolerance Modeling, Tolerance representation - specification, analysis and synthesis, AI in Design.

6. Collaborative Engineering:

Collaborative Design, Principles, Approaches, Tools, Design Systems. Product Data Management (PDM).

Reference Books:

1. Ibrahim Zeid, **CAD/CAM Theory and Practice**, McGraw Hill international.
2. P. N. Rao, **CAD/CAM** Tata McGraw Hill.
3. Foley, Van Dam, Feiner and Hughes, **Computer Graphics Principles and Practice,** second edition, Addison–Wesley, 2000.
4. Martenson, E. Micheal, **Geometric Modelling**, John Wiley & Sons, 1995.
5. Hill Jr, F.S., **Computer Graphics using Open GL**, Pearson Education, 2003.

6. Singeresu S. Rao, **Engineering Optimization-Theory and Practice,** New Age International Limited Publishers, 2000.
7. Johnson Ray, C. **Optimum Design of Mechanical Elements**, Wiley, John & Sons, 1981.
8. P. Radhakrishnan, S. Subramanyam, **CAD/CAM/CIM**, New Age International.
9. V. Ramamurti, **Computer Aided Mechanical Design and Analysis**, Tata Mc Graw Hill-1992.

Software Documentation, tutorials, manuals of following software
1. UG/NX
2. Solid Works
3. CATIA
4. Autodesk Inventor Professional
5. AutoCAD
6. Open CASCADE
7. ANSYS Design Modeller
8. Pro/E

Semester – I
Research Methodology [502404]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502404	4	50	50	-	-	100	4

1. Research Problem
Meaning of research problem, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem

2. Basic Instrumentation
Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP is collected data contains noise.

3. Applied Statistics
Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis

4. Modeling And Prediction of Performance
Setting up a computing model to predict performance of experimental system, Multi-scale modeling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity theory and applications.

5. Developing A Research Proposal
Format of research proposal, Individual research proposal, Institutional proposal, Proposal of a student – a presentation and assessment by a review committee consisting of Guide and external expert only, Other faculty members may attend and give suggestions relevant to topic of research.

Reference Books:

1. Stuart Melville and Wayne Goddard, **Research methodology: An Introduction for Science & Engineering students**.
2. Dr. C. R. Kothari, **Research Methodology: Methods and Trends**
3. Wayne Goddard and Stuart Melville, **Research Methodology: An Introduction**
4. Ranjit Kumar **Research Methodology: A Step by Step Guide for Beginners**, 2nd Edition
5. Dr. S.D. Sharma & Kedar Nath Ram **Operational Research**, Nath & Co.
6. Pressman, **Software Engineering**

Semester – I
Elective – I [502405]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502405	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
ME2I – M1	Energy Audit and Management	**ME2I – M6**	Operation Management
ME2I – M2	Financial Management	**ME2I – M7**	Engineering Economics
ME2I – M3	Financial Costing	**ME2I – M8**	Technology Forecasting
ME2I – M4	Project Management	**ME2I – M9**	Technology Transfer
ME2I – M5	Energy Efficient Technologies in Electrical Systems	**ME2I – M10**	**Human Rights**
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
ME1I – M10	Environmental Pollution and Control	**ME1I – M11**	Intellectual Property Rights

Note: For e.g., ME2I-M1 indicates

ME – Common to all M.E. Mechanical Course, 2 – 2 Credits, I – Elective I, M1 – Module 1

ME2I – M1 Energy Audit and Management

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Reference Books: 1. Guide Books, Bureau of Energy Efficiency

ME2I – M2 Financial Management

Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracting and role of Energy Service Companies (ESCOS).

Reference Books: 1. Guide Books, Bureau of Energy Efficiency

ME2I – M3 Financial Costing

Significance, Traditional absorption costing, Marginal costing, Contract costing, Activity based costing, Process costing

Reference Books: 1. Cost Accounting, N K Prasad, Book Syndicate Pvt. Ltd.

ME2I – M4 Project Management

Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification.

Reference Books: 1. Guide Books, Bureau of Energy Efficiency

ME2I – M5 Energy Efficient Technologies in Electrical Systems

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls.

Reference Books: 1. Guide Books, Bureau of Energy Efficiency

ME2I – M6 Operation Management

Introduction, Importance, Operating systems models, key decisions, Planning and controlling, Strategic approach, Processes and systems, supply chain or network approach, Technology and knowledge management, Quality Management, Operations - Challenges, Opportunities, Excellence, risk management and sustainability, Case studies

Reference Books:

1. Operations Management - An Integrated Approach, Danny Samson and Prakash J. Singh, Cambridge University Press
2. Modern production/Operations Management, 8th Edition, E.S. Buffa and R. K. Sarin, John Wiley & Sons.

ME2I – M7 Engineering Economics

Fundamentals, Markets and Government in a Modern economy, Basic Elements of Supply and Demand, Demand and Consumer Behavior, Analysis of Perfectly Competitive Markets, Unemployment, Inflation and Economic policy

Reference Books: 1. Economics, Samuelson Nordhaus, Tata McGraw Hill

ME2I – M8 Technology Forecasting

Approaches, Technology Performance Parameters, Use of Experts in Technology Forecasting, Planning, Technology Progress. Morphological Analysis of a Technology System.

ME2I – M9 Technology Transfer

Definition, Source of Technology Transfer [TT], Model of TT with Public and Private Enterprises, Success and Failure Factors in Technology Transfer. The concepts of Invention and Innovation, Definition and classifications of Research and Development, New Product Development, Challenges in Commercializing Research Results.

Reference Books: 1. Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M10 Human Rights

Human Rights – Concept, Development, Evolution, Philosophical, Sociological and Political debates, Benchmarks of Human Rights Movement. Human Rights and the Indian Constitution Human Rights & State Mechanisms, Police & Human Rights, Judiciary & Human Rights, Prisons & Human Rights, National and State Human Rights Commissions, Human Rights of the Different Sections and contemporary issues, Citizens' Role and Civil Society, Human Rights and the international scene Primary Information with reference to Engineering Industry

Ref. Books: 1)Study material on UNESCO,UNICEF web site, 2)HUMAN RIGHTS IN INDIA A MAPPING,Usha Ramanathan, 3)Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing , 2005 .This book is an introductory text on international humanitarian law (the laws of war) that provides the basics of law, including excerpts from some of the leading treaty texts. Perfect for a short course in the law -- one to five weeks, 4) Freedom of Information by Toby Mendel - UNESCO , 2008

ME1I – M11 VEnvironmental Pollution and Control

Pollution and Environmental Ethics, Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards Environmental impact and economic aspects, Emission standards and regulations for Automobiles.

Reference Books: 1. Environmental Pollution and Control, J. Jeffrey Peirce, P Aarne Vesilind, Ruth Weiner, Butterworth-Heinemann

2. Environmental Pollution Control Engineering, C.S. Rao, New Age International

ME1I – M12 Intellectual Property Rights

Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents.

Reference Books: 1. Satyawrat Ponkshe, The Management of Intellectual Property, by, Ponkshe & Bhate Publications, Pune.

Semester – I
Lab Practice – I [502406]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502406	4	-	-	50	50	100	4

Lab. work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects excluding Research Methodology and Elective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System. (Refer University web site)

Geometric Modelling & Analysis

Solid modelling, assembly modelling, drafting assignments using software like UNIGRAPHICS, Solid Works, CATIA, Pro/Engineer, I-DEAS, Autodesk Inventor, etc and study of the various facilities in these software's.

Finite Element Analysis Assignments using software's like ANSYS, Hyper Mesh Ls-Dyna, Abacus etc.

List of Assignments

1. Surface Modelling of Mechanical Components.
2. Solid Modeling of Mechanical Components.
3. Assembly modelling of Mechanical Components.
4. Finite Element Analysis of Mechanical Components.
5. Finite Element Analysis of Mechanical Systems.

Semester - II
Computer Integrated Manufacturing [502407]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502407	4	50	50	-	-	100	4

1. **Concept Of CIM**
   Introduction to CIM, Types of Manufacturing, CIM hardware and software, Elements of CIM, Product development through CIM Design Activities in a networked environment, networking in a manufacturing company, hardware elements of networking.

2. **CIM Database**
   Introduction, Database requirements of CIM, Database, Database management, Database Models, EDM, Product Data Management (PDM), Advantage of PDM. , Collaboration Engineering.

3. **Work Cell & Flexible Manufacturing System**
   Manufacturing cell, Group Technology, Cellular Manufacturing. DNC system and transfer of program from PC to machine. Introduction to FMS, Manufacturing integration model, flexible manufacturing strategy, Components of Flexible Manufacturing-Pallets and fixtures, machining centers, inspection equipment, material handling stations, storage system, In-process storage, manually operated stations, allied operation centers

4. **Integrative Manufacturing Planning And Control**
   Role of integrative manufacturing in CAD/CAM integration, Over view of production control - Forecasting, Master production schedule, Capacity planning, M.R.P., Order release, Shop-floor control, Quality assurance, Planning and control systems, Cellular manufacturing, JIT manufacturing philosophy.

5. **Web Based Manufacturing**
   Integrating process with web, Process management and control through web, Applications of web based manufacturing, casting, machining, forming & forging.

6. **Future Trends In Manufacturing Systems**
   Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

Reference Books:

1. Paul G. Ranky, **The Design and Operation of FMS**, I.F.S. Publications 1983
2. Harrington J, **Computer Integrated Manufacturing** Krieger Publications 1979
3. Richard N. Shover, **An Analysis of CAD/CAM Application with Introduction to C.I.M.** Prentice hall
4. David Bedworth et.al **Computer Integrated Design and Manufacturing** McGraw hill 1991
5. Scolz B. Reiter **C.I.M Interfaces** Chapman & Hall 1992
6. David L. Goetsch, **Fundamental of CIM Technology**, Delmar Publication 1988
7. Groover, M.P., (2004), **Automation, Production Systems & Computer Integrated Manufacturing** second edition, Pearson Education ISBN: 81-7808-511-9
8. Groover, Weiss, Nagel, Audrey, Industrial **Robotics-Technology, Programming and Applications**, McGraw Hill.

9. Nanua Singh, **Systems Approach to Computer Integrated Design and Manufacturing,** John Wiley Publications.
10. Alavudeen, Venkateshwaran, **Computer Integrated Manufacturing**, Prentice-Hall India

Semester - II

Industrial Product Design & Product Lifecycle Management [502408]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502408	4	50	50	-	-	100	4

1. Product Development

Quality function deployment-quality project approach and the problem solving process. Design creativity-innovations in design alternatives. Concurrent engineering, industrial design principles. Product development versus design, types of design and redesign, modern production development process, reverse engineering and redesign product development process, examples of product development process, scoping product development – S-curve, new product development.

2. Understanding Customer Needs & Generating Concepts

Gathering customer needs, organizing and prioritizing customer needs, establishing product function, FAST method, establishing system functionality. GENERATING CONCEPTS: Information gathering, brain ball, C-sketch/6-3-5 method, morphological analysis, concept selection, technical feasibility, ranking, measurement theory, DFMA, design for robustness.

3. Product Tear Down and Experimentation

Tear down method, post teardown report, benchmarking and establishing engineering specifications, product portfolios.

4. Introduction to Product Life Cycle Management

Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement,. Threads of PLM-computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM, comparison of PLM to Engineering resource planning (ERP). PLM characteristics -singularity, cohesion, traceability, reflectiveness.

5. Product Life Cycle Environment

Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2tier/3tier/4tier etc).

6. Product Data Management

Benefits and Terminology, CIM Data, PDM functions, definition and architectures of PDM systems, Engineering data, engineering workflow and PDM acquisition and implementation, Resolving Data Issues, product data interchange, present market constraints, collaborative product development, Internet and developments in client server computing, portal integration. Components of a typical PDM setup - hardware and document management – creation and viewing of documents - creating parts-version - control of parts and documents, configuration management for product structure, change management and associated activities.

Reference Books.

1. John W Gosnay and Christine M Mears, Business Intelligence with Cold Fusion, Prentice Hall India, New Delhi, 2000.
2. David S Linthicum, "B2B Application Integration", Addison Wesley, Boston, 2001.
3. Alexis Leon, Enterprise Resource Planning, Tata McGraw Hill, New Delhi, 2002.
4. David Ferry and Larry Whipple, Building and Intelligent e-business, Prima Publishing, EEE Edition, California, 2000.

5. David Bedworth, Mark Hederson and Phillip Wolfe, Computer Integrated Design and Manufacturing, McGraw Hill Inc., New York, 1991.
6. Kevin Otto and Kristin Wood, Product Design – Techniques in Reverse Engineering and New Product Development, Pearson Education, New Delhi, 2004.
7. Karl T Ulrich and Stephen D Eppinger, Product Design and Development, McGraw Hill, New York, 1994.
8. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
9. AnttiSaaksvuori, AnselmiImmonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
10. Stark, John, Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
11. Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw Hill International 1999.
12. Burden Rodger, PDM: Product Data Management, Resource Pub, 2003. ISBN 0970035225
13. Silberschatz, Korth and Sudarshan, Database System Concepts, McGraw Hill, 2002

Semester – II
Automated Manufacturing System Modelling [502409]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502409	4	50	50	-	-	100	4

1. Introduction

Modelling Automated Manufacturing Systems, Performance Modelling Tools.

2. Automated Manufacturing Systems

Introduction, Manufacturing Systems, Performance Measures, Computer-Controlled Machines, Material Handling Systems, Plant Layout, Flexible Manufacturing Systems, Computer Control Systems,

3. Markov Chain Models

Memory less Random Variables, Stochastic Processes in Manufacturing, Discrete Time Markov Chain Models, Continuous Time Markov Chain Models, An Examples Markov Model of a Transfer Line, Birth and Death Processes in Manufacturing, Time Reversible Markov Chains in Manufacturing, Semi-Markov Processes in Manufacturing.

4. Queuing Models

Queues, Notation and Examples, The M/M/1 Queue, The M/M/m Queue, Batch Arrival Queuing Systems, Queues with General Distributions, Queues with Breakdowns, Analysis of a Flexible Machine Centre, Queuing Networks, Open Queuing Networks, Closed Queuing

5. Petri Net Models

Classical Petri Nets, Stochastic Petri Nets, Generalized Stochastic Petri Nets, GSPN Modeling of Kanban Systems, Deadlock Analysis Using Petri Nets, Extended Classes of Timed Petri Nets, Integrated PRQN-GSPN Models.

Reference Books:

1. Narahari Y., Viswanadham N., **Performance Modelling Of Automated Manufacturing Systems,** Prentice-Hall India.
2. Alan A. Desrochers, **Modelling and Control of Automated Manufacturing Systems** IEEE Computer Society Press 1990.
3. Paul M. Stanfield, **Performance Modelling of Automated Manufacturing Systems,** Institute of Industrial Engineers, Inc**.**

Semester – II
Elective – II [502410]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502410	5	50	50	-	-	100	5

Modules of 2 Credits			
Code No.	**Title**	**Code No.**	**Title**
CAD2II – M1	Isoparametric Elements And Formulation of Plane Elasticity Problems	**CAD2II – M3**	Nonlinear Problems – Geometric, Material And Contact Problems
CAD2II – M4	Dynamic Problems – Eigen Value and Time Dependent Problems	**CAD2II – M5**	Finite Difference Solutions
CAD2II – M6	Finite Volume Methods	**CAD2II – M8**	Advanced Materials
CAD2II – M9	Alloys	**CAD2II – M10**	Ceramics
CAD2II – M11	Composites	**CAD2II – M13**	Data Models
CAD2II – M15	Distributed Database	**CAD2II – M16**	Web Languages
CAD2II – M17	J2ee Technologies:	**CAD2II – M18**	Ejb3, Ajax
CAD2II – M19	Tools For Customization	**CAD2II – M23**	Automated Solid Modeling Using Customization
Modules of 1 Credit			
Code No.		**Title**	
CAD1II – M2	Plate Bending Problems – Plate And Shell Elements	**CAD1II – M7**	Turbulence Modeling
CAD1II – M12	Relational Database Design	**CAD1II– M14**	File & System Structure
CAD1II – M20	Computer-Based System Engineering	**CAD1II– M21**	Rapid Development
CAD1II – M22	Solid Modelling Algorithms		

CAD2II – M1: Isoparametric Elements and Formulation of Plane Elasticity Problems

Introduction, shape functions – linear & quadratic, displacement function – criteria for the choice of the displacement function, polynomial displacement functions, displacement function in terms of nodal parameters, strain-nodal parameter relationship, stress-strain relationship, element stiffness matrix, convergence of isoparametric elements, numerical integration – Trapezoidal rule, Simpson's 1/3 rule, Newton-Cotes Formula, Gauss Quadrature formula, Guass Quadrature in two and three dimensions.

Introduction, thin and thick plates – Kirchhoff theory, Mindlin plate element, triangular and rectangular, conforming and nonconforming elements, degenerated shell elements, reduced and selective integration, shear locking and hour glass phenomenon.

CAD2II – M3: Nonlinear Problems – Geometric, Material and Contact Problems

Introduction to non-linear analysis, formulation for geometrical, material and contact nonlinear problems, Nonlinear equation solving procedure - direct iteration, Newton-Raphson method, modified Newton-Raphson method, incremental techniques.

CAD2II – M4: Dynamic Problems – Eigen Value and Time Dependent Problems

Formulation of dynamic problems, consistent and lumped mass matrices Solution of Eigen value problems – transformation methods, Jacobi method, Vector Iteration methods, subspace iteration method Forced vibration – steady state and transient vibration analysis, modelling of damping, the mode superposition scheme, direct integration methods – implicit and explicit numerical integration.

Reference Books:

1. Seshu P., **Text book of Finite Element Analysis**, PHI Learning Private Ltd., New Delhi, 2010.
2. Mukhopadhyay M and Sheikh A. H., **Matrix and Finite Element Analyses of Structures**, Ane Books Pvt. Ltd., 2009.
3. Bathe K. J., **Finite Element Procedures**, Prentice-Hall of India (P) Ltd., New Delhi.
4. Cook R. D., **Finite Element Modeling for Stress Analysis**, John Wiley and Sons Inc, 1995
5. Chandrupatla T. R. and Belegunda A. D., **Introduction to Finite Elements in Engineering**, Prentice Hall India.
6. Liu G. R. and Quek S. S. **The Finite Element Method – A Practical Course**, Butterworth-Heinemann, 2003.
7. Reddy, J. N., **An Introduction to The Finite Element Method**, Tata McGraw Hill, 2003.
8. Reddy, J. N., **An Introduction to Nonlinear Finite Element Analysis**, Oxford University Press, 2010.
9. Dixit U. S., **Finite Element Methods for Engineers**, Cengage Learning India Pvt. Ltd., 2009.

CAD2II – M5: Finite Difference Solutions

Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method.

CAD2II – M6: Finite Volume Methods

Introduction to finite volume method, finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of staggered grids simple algorithm.

CAD2II – M7: Turbulence Modeling

Turbulence energy equation- one-equation model, the k-ω model, the k- ε model

Reference Books:

1. John D Anderson, **Computational Fluid Dynamics – The Basics with Applications**, McGraw Hill, New Delhi, 1995.
2. Muralidhar K and Sundararajan T, **Computational Fluid Flow and Heat Transfer**, Narosa Publications, 2003.
3. Chung T J, **Computational Fluid Dynamics**, Cambridge University Press, London, 2002.
4. David C Wilcox, **Turbulence Modeling for CFD**, DCW Industries, Inc., 1993.
5. Versteeg H K and Malalasekara W, **An Introduction to Computational Fluid Dynamics - The Finite Volume Method**, Longman, 1995.
6. Pradip Niyogi, Chakrabartty SK, Laha M.K., **Introduction to Computational Fluid Dynamics**, Pearson Education, 2005.
7. Patankar, S.V, **Numerical Heat Transfer and Fluid flow**, Hemisphere Publishing Company, New York, 1980.

CAD2II – M8: Advanced Materials

HSLA steels, tool and die materials, alloy cast irons, stainless steels, PH and maraging steels, materials for low temperature applications, refractory metals and super alloys, Hadfield steels, ball bearing steels and bearing metals.

CAD2II – M9: Alloys

Automobile alloys and aerospace alloys, Inter metallics, Ni and Ti Aluminides - Smart materials, shape memory alloys -Metallic glass - Quasi crystal and nano Crystalline materials.

CAD2II – M10: Ceramics

Ceramic crystal structures – Binary ceramic structures: Rock salt, Fluorite, Rutile and Silica structures. Ternary ceramic structures. Introduction to phase equilibria in ceramics, Phase equilibrium diagrams and composition calculations. Thermal, Electrical, magnetic and optical behavior of ceramics, Mechanical behavior of ceramics, Engineering ceramics and their applications, (Glass and Glass-ceramics, Aluminum oxide, Silicon nitride, Zirconia and zirconia-Toughned Aluminum, Sailons)

CAD2II – M11: Composites

Fundamentals, Definition, classification of composite materials, laws of mixtures, factors affecting composite properties: interfacial bonding. Mechanical Behaviour of composite, Young's Modulus and strength considerations for continuous FRCs & short FRCs, Toughening Mechanisms in composites. Fabrication & Properties of fibers-Glass fibers, carbon fibers, Aramid fibers, Silicon Carbide Fibers & Metallic Glasses.

Reference Books:

1. R.S.Kurmi & R.S.Sedha, **Material Science**, S. Chand & company Ltd.
2. Thomas H. Courtney, **Mechanical Behavior of Materials,** McGraw-Hill.
3. Michael F. Ashby, **Material Selection in Mechanical Design,** Butterworth-Heinemann Ltd.
4. Flinn, R.A. and Trojan, P.K., **Engineering Materials and their Applications,** Wiley 1995.
   Issac Daniel, Ori Ishai, **Engineering Mechanics of Composite Materials,** Oxford University Press, 2006.

CAD2II – M12: Relational Database Design

Relational model and relational database design: Structure of relational database, former query languages, commercial query languages. Modifying the database views. Pitfalls in relational database design and normalization.

CAD2II – M13: Data Models

Network data model and hierarchical data model: data structure diagram, the DBTCCODASYL. Model data retrieval Update and set processing facility, three structure diagram, data retrieval and update facility, virtual records.

CAD2II – M14: File & System Structure

File and System Structure, Indexing and Hashing: Physical storage media – file organization, buffer management, Mapping relations, networks and hierarchies to files – Index – sequential files. Bi-tree indexed files.

CAD2II – M15: Distributed Database

Distributed database, security and integrity: Design, transparency and autonomy, query processing, recovery, concurrency control, deadlock handling and coordinator selection. Security and integrity, near database application.

Reference Books:

1. Korth, H.F. Silbenhatz, A., **Database Concepts**, Mc Graw Hill, 1986.
2. Gio Wiederhold, **Database Design**, Mc Graw Hill, 1983.
3. Jefferey O Ullman, **Principles of database systems**.
4. C.J. Date, **An Introduction to database systems**, Addison Wisely, 1980.
5. Trembley and Soreson, **An Introduction to Data structures with applications**, Mc Graw Hills.

CAD2II – M16: Web Languages

Web: History of Web application, W3C, Introduction to various web building technologies. Mark up languages: Use of markup languages in building web applications, Hypertext Markup language (HTML), (Extensible mark-up Language) XML, XML Parsers: What is parsing, Types of parsers, benefits and limitations of each parser.

CAD2II – M17: J2EE Technologies

JSP- What is JSP, JSP architecture, Session in JSP, Cookies and use of cookies. Servlet- Introduction to Servlet technology, web container, Methods of Servlet, Lifecycle of a servlet, advantages of servlet, HTTP session listener and filters in servlet.

CAD2II – M18: EJB3, AJAX

Introduction to Application server, Features of enterprise beans, benefits of EJB, Annotations, Introduction to POJO, stateless and stateful session beans.

Ajax- Introduction to framework, rule of ajax in enhancing user experience, ajax examples. Distributed Computing Concepts of Client-Server Architecture (2-Tier, 4-Tier, n-Tier).

CAD2II – M19: Tools for Customization

Object Oriented Programming (OOP), OLE interfaces in CAD/CAM software; Use of General programming interfaces like VB, VBS, VC++, Open GL programming and System dependent programming interfaces like Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro/Engineer)

CAD2II – M20: Computer-Based System Engineering

System Engineering process, Software product development life cycle, software processes, software development project management, software prototyping.

Reference Books:

1. Ian Summerville, **Software Engineering**, Pearson Education.
2. Foley, van Dam, **Computer Graphics**, Pearson Education.
3. Mason Woo, et al, **OpenGL Programming Guide.**
4. George Omura**, Advanced AutoCAD**.
5. Sham Tickoo, **Customizing AutoCAD**, Thomson learning

CAD2II – M21: Rapid Development

Core issues in rapid development, rapid development languages, lifecycle planning and customer oriented development.

Reference Books:

1. Steve McConnell, **Rapid development**, Microsoft Press.

CAD2II – M22: Solid Modelling Algorithms

Euler operations, basic solid modelling algorithms

CAD2II – M23: Automated Solid Modeling Using Customization:

Creating 2D, 3D and solid entities through API, Editing 2D, 3D and solid entities through API, Design and development of user interfaces - icons, menus, dialog boxes, Integrating databases with CAD; creating BOM or part lists, Automated Assembly modelling through customization, Automated drafting and dimensioning using customization, Creating Automated Animations using API and animation software.

Reference Books:

1. Martti Mantilya, **Solid Modelling**, Computer Science Press.

Semester – II
Lab Practice – II [502411]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502411	4	-	-	50	50	100	4

Lab. work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects excluding Elective. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System. (Refer University web site)

SIMULATION & OPTIMIZATION

04- 06 Assignment on real life problems of manufacturing systems and manufacturing processes to be simulated using simulation software's as ARENA, FORGE, FASTFORM ADVANCED, PAMSTAMP, SIMUFACT FORMING etc. Assignments on optimization using any process/product optimization software.

Assignments:

1. Assignment on Finite Element Simulation of Cooling/Heating Process.
2. Assignment on Finite Element Simulation of Bending Process.
2. Assignment of Finite Element Simulation of Drawing/Forming.
4. Assignment on Tool Path Simulation of Turning/Milling.
5. Assignment on Process Optimization.

Seminar – I, II and III [502412, 602416, 602418]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502412	4	-	-	50	50	100	4
602416	4	-	-	50	50	100	4
602418	5	-	-	50	50	100	5

Assessment of Seminar has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR SEMINAR I/II/III REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare 3 **COPIES** of your manuscript.
2. Limit your project report to preferably
    a) 15-20 manuscript pages Seminar I
    b) 20-25 manuscript pages Seminar II
    c) 25-30 manuscript pages Seminar III
3. The footer

For Computer Aided Design, Manufacture & Engineering

Institute Name, Mechanical (CADME) Bookman Old Style 10 pt. and centrally aligned.

4. Page number at second line of footer, Bookman Old Style 10 Pt, centrally aligned
5. Print the manuscript using
    a) Letter quality computer printing.
    b) The main part of manuscript should be Bookman Old Style 12 pt. and justified**.**
    c) Use 1.5 line spacing.
    d) Entire report shall be one chapter. No chapters for Seminar I, II, and III.
    e) Seminar I shall not have last section as Conclusions, it will be summary only.
6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	**Paper 8.5'' × 11''**	**Paper A4 (210 × 197 mm)**
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	**1''**	**25.4 mm**

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.
8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.
9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear**.**
    a) Illustrations should not be more than **two** per page. One could be ideal
    b) Figure No. and Title at bottom with **12 pt**
    c) Legends below the title in **10 pt**
    d) Leave proper margin in all sides
    e) Illustrations as far as possible should not be xeroxed.
11. **Photographs** if any should of glossy prints
12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.
13. Please **number the pages** on the front side, centrally below the footer
14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author
15. **Symbols** and **notations** if any should be included in nomenclature section only
16. Following will be the order of report
    i. **Cover page** and **Front page** as per specimen on separate sheet
    ii. **Certificate** from institute as per specimen on separate sheet
    iii. **Acknowledgement**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Bookman Old Style, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract.
    ix. Section : Introduction
    x. References
17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references.

Reference Books

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent no, Country (in parenthesis), date of application, title, year.

Internet

www.(Site) [Give full length URL]

Format for front page and Certificate

A Seminar I / II / III on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name(TNR, 16pt, Centrally Aligned)

Guide (TNR, 16pt, Centrally Aligned)

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2011-12](TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute

Logo

C E R T I F I C A T E

This is to certify that *Mr. Lele M.M.*, has successfully completed the seminar-I/II/III entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Computer Aided Design, Manufacture & Engineering) of University of Pune.

Date :

Place :

Guide's Name
Guide

_____
Head
Department and
Institute Name

External Examiner

Seal

_____
Principal,
Institute Name

Semester - III
Simulation Modelling [602413]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602413	4	50	50	-	-	100	4

1. Introduction To Simulation

Definition – history - nature of computer Modelling and simulation, limitations of simulation, areas of application. System and environment**:** Components of a system – types of simulation - discrete and continuous systems. Modelling approaches – simulation examples - manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.

2. Random Number Generation And Testing

Techniques for generating random numbers – mid square method – mid product method - constant multiplier technique - additive congruential method - linear congruential method – combined linear congruential generators – feedback shift register generators - tests for random numbers – frequency test - the Kolmogorov-Smirnov test, the chi-square test. Independence test – runs up and runs down, runs above and below the mean, autocorrelation.

3. Random Variate Generation

Inverse transform technique - exponential distribution, uniform distribution, Weibull distribution, Triangular distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution. empirical discrete distribution - discrete uniform distribution-poisson distribution - geometric distribution - acceptance - rejection technique for poisson distribution - gamma distribution.

4. Stages In Model Building

Input modelling **–** data collection, identifying the distribution with data, parameter estimation, goodness of fit tests, selecting input models without data, models of arrival processes. Verification and validation of simulation models **–** variance reduction techniques, antithetic variables, calibration and validation of models. output analysis – stochastic nature of output data, measures of performance and their estimation, output analysis for terminating simulation.

5. Manufacturing Systems Modelling

Objectives and performance measures – modelling system randomness – sources of randomness, machine downtime – case study.

6. Introduction To Simulation Packages And Exercises

Model building using SIMULATION PACKAGES.

Text/Reference Books:

1. Jerry Banks, John S, Carson II, Barry L Nelson and David M Nicol, **"Discrete Event System Simulation",** Prentice Hall Inc., 2006.
2. Law A M, **"Simulation Modeling and Analysis**", Tata McGraw Hill Companies Inc, 2008.
3. Gordon G, **"Systems Simulation**", Prentice Hall Ltd., 2006.
4. Narsingh Deo, **"System Simulation with Digital Computer**", Prentice Hall of India, 2007.
5. Francis Neelamkovil, **"Computer Simulation and Modeling**", John Wiley and Sons, 1987.
6. Ruth M Davis and Robert M O'Keefe, "**Simulation Modeling with Pascal",** Prentice Hall Inc., 1989.

Semester – III
Optimization Techniques [602414]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602414	4	50	50	-	-	100	4

1. Introduction To Optimization
Introduction to optimization, formulation of optimization problem, Classification of optimization problems, Optimum design of components like pins, beams, columns, shafts, spur gears, pressure vessels, etc.

2. Linear Programming
Linear programming, simplex method and duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's method

3. One Dimensional Optimization
One dimensional minimization, optimality criterion, minimum bracketing methods like exhaustive search method, bounding phase method; optimum seeking methods like interval halving, golden section search, successive quadratic estimation, Newton Raphson, bisection, secant, cubic search method

4. Multi-Dimensional Optimization
Multivariable unconstrained optimization, optimality criteria, direct search methods Powell's conjugate direction method; gradient search methods like Cauchy's method, Newton's method, conjugate gradient method and variable metric method.

5. Constraint Based Optimization Methods
Constrained Optimization, Optimality conditions, Optimization methods like penalty function method, method of multipliers, variable elimination method, complex search method, random search method, cutting plane method, feasible direction method, generalized reduced gradient method

6. Evolutionary Optimization
Introduction, working & Advantages of Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization

Text Books:

1. S. S. Rao, **Engineering Optimization Theory and Practice**, New age international (P) Ltd., reprint 2003
2. Kalyanmoy Deb, **Optimization for Engineering Design**, PHI, New Delhi, 2005
3. J. S. Arora, **Introduction to Optimum Design**, McGraw Hill, New York, 1989.

Reference Books:

1. S. S. Stricker, **Optimizing Performance of Energy Systems,** Battelle Press, New York, 1985.
2. R.C. Johnson, **Optimum Design of Mechanical Elements**, Willey, New York, 1980.
3. L.C.W. Dixon, **Non-Linear Optimization - Theory and Algorithms**, Birkhauser, Boston, 1980.
4. R.J. Duffin, E.L. Peterson and C. Zener, **Geometric Programming-Theory and Applications**, Willey, New York, 1967.
5. G.B. Dantzig **Linear Programming and Extensions Princeton University Press**, Princeton, N. J. 1963.
6. R. Bellman, **Dynamic Programming** Princeton University Press, Princeton, N.J. 1957.

Semester – III
Elective – III [602415]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602415	5	50	50	-	-	100	5

Modules of 2 Credits			
Code No.	**Title**	**Code No.**	**Title**
CAD2III – M1	Metal Cutting and Mechanics of Metal Cutting	**CAD2III – M2**	Abrasive Processes
CAD2III – M3	Forming Processes	**CAD2III – M4**	Unconventional Machining Processes
CAD2III – M5	High Speed Machining	**CAD2III – M6**	Liquid-Based Rapid Prototyping Systems
CAD2III – M7	Solid - Based Rapid Prototyping Systems	**CAD2III – M8**	Powder Based Rapid Prototyping Systems
CAD2III – M11	Material Handling Systems	**CAD2III – M12**	Robot Kinematics
CAD2III – M13	Robot Force Analysis	**CAD2III – M14**	Robot Sensors and Controllers
CAD2III – M16	Plastic Deformation In Metals:	**CAD2III – M18**	Sheet Metal Forming
CAD2III – M20	Kanban System	**CAD2III – M30**	Design of Experiments and Analysis Of Variance
Modules of 1 Credit			
Code No.		**Title**	
CAD1III – M9	Rapid Prototyping Data Formats	**CAD1III – M10**	Rapid Prototyping Applications
CAD1III – M15	Robot Programming	**CAD1III– M17**	Forming Equipment
CAD1III – M19	Just In Time Production System	**CAD1III– M21**	Design For Manufacturing, Assembly And Disassembly
CAD1III – M22	Design For Assorted Technical Requirements/ Processes	**CAD1III – M23**	Design For Life Cycle
CAD1III – M24	Design For Reliability, Quality	**CAD1III – M25**	Introduction To ERP
CAD1III – M26	Modules In ERP	**CAD1III – M27**	Introduction to Digital Manufacturing
CAD1III – M28	Benchmarking The Supply Chain	**CAD1III – M29**	Managing the Supply Chain

CAD2III – M1: Metal Cutting and Mechanics Of Metal Cutting

Introduction to metal removal processes, Chip formation, forces acting on cutting tool and their measurement, Chip thickness, Theory of Ernest and Merchant, theory of Lee and Shafer, Tool wear and tool life, surface finish, thermal aspects, friction in metal cutting and testing of machine tools.

CAD2III – M2: Abrasive Processes

Introduction, Grinding wheel-designation and selection, grinding process, grinding process parameters, creep feed grinding, honing, lapping and other finishing processes

CAD2III – M3: Forming Processes

Sheet metal forming, punching, extrusion, coning. Plastic molding process, injection molding, blow molding, compression molding. Metal injection molding, powder injection molding, sintering process, and their applications.

CAD2III – M4: Unconventional Machining Processes

Need for unconventional processes, Range of non conventional machining processes USM, WJM, AJM, chemical machining, Electrochemical machining, Electrolytic grinding, EDM, LBM, EBM, Plasma arc cutting.

CAD2III – M5: High Speed Machining

Introduction to high speed machining, economics of high speed machining, brief historical perspective, material properties at high strain rates, influence of increasing speed on chip formation, stainless steel, aerospace aluminium and titanium and recommendations.

Reference/Text Books:

1. G. Boothroyd and W. A. Knight, **Fundamentals of Machining and Machine Tools,** CRC Press.
2. E. M. Trent and P. K. Wright, **Metal Cutting,** Butterworth- Heinemann, Boston.
3. P. N. Rao, **Manufacturing Technology,** Tata Mc-Graw Hill.
4. D. A. Stephenson and J. S. Agapiou, **Metal Cutting Theory and Practice,** CRC Press
5. Kalpak Jain S. and Schmid S. R., **Manufacturing Processes for Engineering Materials, Addition Wesley,**
6. Mikell P. Groover, Fundamentals **of Modern Manufacturing: Materials, Processes, and Systems**, John Wiley & Sons.
7. G. Boothroyd and W. A. Knight, **Fundamentals of Machining and Machine Tools,** CRC Press.
8. E. M. Trent and P. K. Wright, **Metal Cutting,** Butterworth- Heinemann, Boston.
9. P. N. Rao, **Manufacturing Technology,** Tata Mc-Graw Hill.
10. D. A. Stephenson and J. S. Agapiou, **Metal Cutting Theory and Practice,** CRC Press
11. Kalpak Jain S. and Schmid S. R., **Manufacturing Processes for Engineering Materials, Addition Wesley,**
12. Mikell P. Groover, Fundamentals **of Modern Manufacturing: Materials, Processes, and Systems**, John Wiley & Sons.

CAD2III – M6: Liquid-Based Rapid Prototyping Systems

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Model sand specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

CAD2III – M7: Solid-Based Rapid Prototyping Systems

Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

CAD2III – M8: Powder Based Rapid Prototyping Systems

Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Three dimensional printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

CAD1III – M9: Rapid Prototyping Data Formats

STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3D View, Velocity 2, Rhino, STL View 3 Data Expert and 3D doctor.

CAD1III – M10: Rp Applications

Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customised Implants & Prosthesis.

REFERENCE/TEXT BOOKS:

1. Amitabha Ghosh, **Rapid Prototyping**
2. Kalpak Jain S. and Schmid S. R., **Manufacturing Processes for Engineering Materials, Addition Wesley,**

CAD2III – M11: Material Handling Systems

Material Transport Systems - Industrial trucks, automated guided vehicle systems (AGVS), vehicle guidance technology, vehicle management and safety, monorails and other rail guided vehicles, conveyor systems, types of conveyors, conveyor operations and features, cranes and hoists, analysis of material transfer systems, charting techniques in material handling, analysis of vehicle-based systems, conveyor analysis

CAD2III – M12: Robot Kinematics

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

CAD2III – M13: Robot Force Analysis

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots, Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control

CAD2III – M14: Robot Sensors And Controllers

Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and pre-processing. Segmentation and region characterization object recognition by image matching and based on features

CAD1III – M15: Robot Programming

Robot languages: AL, AML, RAIL, RPL, VAL, demonstration of points in space: Continuous path (CP), Via points (VP), Programmed points (PP).

Reference/Text Books:

1. Nagrath and Mittal, **Robotics and Control**, Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, **Robot Dynamics and Control**, John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, **Robotics, Control, Sensing, Vision And Intelligence**, McGraw Hill International, 1987
4. Steve LaValle, **Planning Algorithms**, Cambridge University. Press, New York, 2006.
5. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, **Principles of Robot Motion: Theory, Algorithms, and Implementations**, Prentice Hall of India, 2005.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, **Robotic Engineering - An Integrated Approach,** Prentice-Hall of India Private Limited, 1994.

CAD2III – M16: Plastic Deformation in Metals

The flow curve, true stress, true strain, yielding criteria for ductile metals, plastic stress – strain relations, strain hardening coefficient, normal anisotropy coefficient, formability evaluations, drawability tester, high strength, low alloy steels developed for formability: HSLA steels, Dual phase steels, DQAK steels, CHR-X steels, two- dimensional plastic, flow – slip line field theory, Mechanics of metal working, Temperature in metal working, strain rate effects, metallurgical structures, Friction and lubrication, lubricants for hot and cold working, Deformation zone geometry, workability and residual stresses.

CAD1III – M17: Forming Equipment

Types and press construction, Principle of working of Mechanical, Hydraulic and Pneumatic press. Press control system in forging equipments, Presses for hydro forming, selection of presses.

CAD2III – M18: Sheet Metal Forming

Press tool operations - classification based on type of stresses, Shearing operations (blanking and piercing), and effect of clearance, Calculation of punching force, Trimming, Shaving, Nibbling and Notching operations, Drawing and Deep drawing, redrawing, limiting draw ratio, forming limit criteria draw die design. Bending, spring back in bending. Spinning, stretch forming, Embossing, Coining, Rubber forming. Defects in formed parts. Sheet Metal Forming Dies – progressive die, compound and combination die. Die Construction, Centre of pressure calculation, Stock strip layout, Strip development

Reference/Text Books:

1. Grobh Schuler, **Metal forming handbook,** Springer Verlag Berlin, Heidelberg, 1998, ISBN-3-540-61185-1

CAD1III – M19: Just In Time Production System

JIT Logic -Pull system, Japanese approach to production elimination of waste, JIT implementation requirements, JIT application for job shops

CAD2III – M20: Kanban System

Kanban rules supplier Kanban and sequence schedule used by supplier, Monthly information & daily information, later replenish system by Kanban sequenced withdrawal P system by sequence schedule table -problems & counter measures in applying Kanban system to subcontractors - Supplier Kanban circulation in the paternal manufacturer - structure of supplier Kanban sorting office.

Reference/Text Books:

1. Yasuhiro Monden, **"Toyoto Production System -An integrated approach to Just in Time"**, Engineering and Management Press, Institute of Industrial Engineers, Norcross Georgia.

CAD1III – M21: Design For Manufacturing, Assembly And Disassembly

Principles, approaches, Product and component, DFMA, The R & D Experience, Evaluations for DFMA.

CAD1III – M22: Design For Assorted Technical Requirements/ Processes

Material storage and distribution, Dimensional control, Heat treatment, Coating, Casting, Plastic processes.

CAD1III – M23: Design For Life Cycle

Approaches to product development, Inspect ability, Serviceability.

CAD1III – M24: Design For Reliability, Quality

Approaches, QFD, Evaluations and Procedures. Design for Quality. Design for Recycling

Reference/Text Books:

1. G. H. Haung, **Design for X: Concurrent Engineering Approach**, Chapman & Hall, 1996.
2. Corrado Poli, **Design for Manufacturing: A Structured Approach**, Butterworth Heinemann
3. James Barilla, **Design for Manufacturability Handbook,** Mc Graw Hill

4. David M. Anderson, **Design for Manufacturing and Concurrent Engineering**, CIM press, 2004.

CAD1III – M25: Introduction to ERP

Introduction, Evolution of ERP, Reasons for growth of ERP, Advantages / disadvantages of ERP, Evaluation of ERP, Various

CAD1III – M26: Modules in ERP

Modules in ERP: Finance and Controlling, Sales and Distribution, Materials Management, Production Planning and Control, Quality Management, Planet Maintenance, Human Resource.

Reference/Text Books:

1. V.K. Garg & N.K. Venkitakrishnan, **ERP Ware: ERP Implementation framework**
2. V.K. Garg & N.K. Venkitakrishnan**, ERP Concepts and Planning**

CAD1III – M27: Introduction to Digital Manufacturing

A Brief History of Manufacturing, Digital Manufacturing Today, Digital Design, Digital Materials, Digital Fabrication, Digital Products, Technology Development, Applications Development, People and Business, The Digital Economy, Transition from Industrial Manufacturing.

Reference/Text Books:

1. Zude Zhou, Shane Xie, Dejun Chen, **Fundamentals of Digital Manufacturing Science,** Springer

CAD1III – M28: Benchmarking the Supply Chain

Benchmarking the logistics process – mapping supply chain processes – supplier and distribution benchmarking – setting benchmarking priorities – identifying logistics performance indicators.

CAD1III – M29: Managing the Supply Chain

Creating logistics vision – problems with conventional organizations – developing logistics organizations - logistics as a vehicle for change – need for integration – managing supply chain as a network – process integration and ECR – co-maker ship and logistics partnerships – supplier development.

Reference/Text Books:

1. Martin Christopher, - **Logistics and Supply Chain Management – Strategies for reducing cost and improving service**, Pitman Publishing, II Edition, 1998.
2. Robert B Handfield and Ernest L Nicholas Jr., **Introduction to Supply Chain Management**, Prentice Hall, NJ, 1999.
3. Donald J Bowersox and David J Closs, **Logistical Management**, Tata McGraw Hill, New Delhi, 2000.
4. David Taylor and David Brunt, **Manufacturing Operations and Supply Chain Management**, Thomson Learning, 2001.
5. David Simchi and Levi, **Designing and Managing the Supply Chain**, McGraw Hill, 2000.

CAD2III – M30: Design of Experiments and Analysis of Variance

Experimental designs – full factorial, partial factorial, Taguchi's orthogonal array method, completely randomized block, Latin square design (only problems). ANOVA-One way and two way classifications, Multi way ANOVA.

Reference/Text Books:

1. Douglas C. Montgomery, **Design and Analysis of Experiments,** Wiley Publications

Project Stage – I and II [602417, 602419]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602417	8	-	-	50	50	100	8
602419	20	-	-	150	50	200	20

Assessment of Project stage-I has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR DISSERTATION WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare 3 **COPIES** of your manuscript.
2. Limit your Dissertation report to 80 – 120 pages (preferably)
3. The footer For Computer Aided Design, Manufacture & Engineering, Institute Name, Mechanical (Computer Aided Design, Manufacture & Engineering) Times New Roman 10 pt. and centrally aligned.
4. Page number as second line of footer, Bookman Old Style, 10 Pt, centrally aligned
5. Print the manuscript using
    a) Letter quality computer printing.
    b) The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
    c) Use 1.5 line spacing.
    d) Entire report shall be of 5- 7 chapters. i.e.

Abstract (half page)

i. **Introduction** (2-3 pages) (TNR – 14 Bold)
    1.1 Problem statement, Need (TNR – 12)
    1.2 Objectives
    1.3 Scope
    1.4 Methodology

ii. **Literature Review** (20-30 pages)

Discuss the work done so far by researchers on the domain area and their significant conclusions. No derivations are expected.

iii. This chapter shall be based on your own contribution in simulation (Analytical/ Numerical) (15- 20 pages)

iv. This chapter shall be based on either a) experimental work OR b) Finite Element / CFD Analysis (15-20 pages)

v. Concluding Remarks and Scope for the Future Work (2-3 pages)

ANNEXURE (if any)

(Put all mathematical derivations, Simulation program as Annexure)

References

1. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

2. All paragraphs will be 1.5 lines spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.
3. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.
4. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).
5. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a) Illustrations should not be more than **two** per page. One could be ideal
    b) Figure No. and Title at bottom with **12 pt**
    c) Legends below the title in **10 pt**
    d) Leave proper margin in all sides
    e) Illustrations as far as possible should not be xeroxed.
6. **Photographs** if any should of glossy prints
7. Please use **SI** system of units only.
8. Please **number the pages** on the front side, centrally below the footer
9. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author
10. **Symbols** and **notations** if any should be included in nomenclature section only
11. Following will be the order of report
    i. **Cover page** and **Front page** as per specimen on separate sheet
    ii. **Certificate** from institute as per specimen on separate sheet
    iii. **Acknowledgements**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**

vii. **Contents**

viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract.

ix. Section : Introduction

x. References

12. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.
13. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent no, Country (in parenthesis), date of application, title, year.

Internet

www.(Site) [Give full length URL]

A Project Stage-I Report on (TNR, 16pt, centrally aligned)

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By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name(TNR, 16pt, Centrally Aligned)

Guide

Guide's Name (TNR, 16pt, Centrally Aligned)

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Department of Mechanical Engineering

Name of the Institute

[2011-12](TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute

Logo

C E R T I F I C A T E

This is to certify that *Mr. Lele M.M.*, has successfully completed the Project Stage-I entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Computer Aided Design, Manufacture & Engineering) of University of Pune.

Date :

Place :

Guide's Name
Guide

_____
Head
Department and
Institute Name

External Examiner

Seal

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Principal,
Institute Name

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By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name(TNR, 16pt, Centrally Aligned)

Guide

Guide's Name (TNR, 16pt, Centrally Aligned)

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Department of Mechanical Engineering

Name of the Institute

[2011-12](TNR, 22pt, Title Case Centrally Aligned)

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Date :

Place :

Guide's Name
Guide

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Head
Department and
Institute Name

External Examiner

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