VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)

MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Two Year Postgraduate Programmme Leading to

Master of Technology (M.Tech.) Degree in

Mechanical Engineering with specialization in

CAD/CAM & AUTOMATION

Implemented from the batch admitted in Academic Year 2014-15

SEMESTER-I

Scheme of Instruction				Scheme of Evaluation				
S. No	**Course Code**	**Course Title**	**L-T-P (Hours/ week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE (hours)**
1	ME5011S	Computational Methods	3-1-0=4	4	20	20	60	3
2	ME5021S	Robotics	3-1-0= 4	4	20	20	60	3
3	ME5022T	Computer Aided Design	3-0-0= 3	3	20	20	60	3
	ME5022P	Computer Aided Design Lab	0-0-2= 2	1	100% CIE			3
4	ME5023T	Automation & Mechatronics	3-0-0= 3	3	20	20	60	3
	ME5023P	Automation & Mechatronics Lab	0-0-2= 2	1	100% CIE			
5		Program Elective Course 1	3-1-0= 4	4	20	20	60	3
6		Program Elective Course 2	3-0-0= 3	3	20	20	60	3
		Program Elective Course 2 Lab	0-0-2= 2	1	100% CIE			
Total Hours			**27**	**24**				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In semester tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

SEMESTER-II

Scheme of Instruction				Scheme of Evaluation				
S. No	**Course Code**	**Course Title**	**L-T-P (Hours/ week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE (hours)**
1	ME5015S	Research Methodologies	3-1-0=4	4	20	20	60	3
2	ME5024S	Advanced Manufacturing Processes	3-1-0= 4	4	20	20	60	3
3	ME5025T	Computer Integrated Manufacturing	3-0-0= 3	3	20	20	60	3
	ME5025P	Computer Integrated Manufacturing Lab	0-0-2= 2	1	100% CIE			3
4	ME5026T	Finite Element Methods	3-0-0= 3	3	20	20	60	3
	ME5026P	Finite Element Methods Lab	0-0-2= 2	1	100% CIE			
5		Program Elective Course 3	3-0-0= 3	3	20	20	60	3
6		Program Elective Course 4	3-0-0= 3	3	20	20	60	3
7		Program Elective Course 4 Lab	0-0-2= 2	1	100% CIE			
8	ME5801D	Technical Seminar	0-0-4= 4	2	100% CIE			
Total Hours			**30**	**25**				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In semester tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

List of Elective I:

S. No	Course code	Course Title
1.	ME5118S	System Modeling &Analysis
2.	ME5119S	Energy Conservation & Management
3.	ME5120S	Reliability Engineering

List of Elective II:

S. No	Course code	Course Title
1.	ME5124T ME5124P	Fluid power Automation Fluid power Automation Lab
2.	ME5121T ME5121P	Rapid Product Development Rapid Product Development Lab
3.	ME5126T ME5126P	Operations management Operations management Lab

List of Elective III :

S. No	Course code	Course Title
1.	ME5133S	Pressure Vessel Design
2.	ME5122S	Process Equipment Design
3.	ME5123S	Design of material handling equipment

List of Elective IV:

S. No	Course code	Course Title
1.	ME5127T ME5127P	Advanced Machine Design Advanced Machine Design Lab
2.	ME5114T ME5114P	Computational Fluid Dynamics Computational Fluid Dynamics Lab

SEMESTER-III & IV

Sr. No	Course Category	Course Title	Credits	Evaluation pattern	Semester
1.	Project (ME6901D)	Stage –I Presentation	4	Graded evaluation by a committee of at least two examiners including supervisor (guide)	III
2.	Project (ME6902D)	Stage –II Presentation	4	Graded evaluation by a committee of atleast two examiners including supervisor (guide)	III
3	Project (ME6903D)	Stage –III Presentation	4	Graded evaluation by a committee of at least two examiners including supervisor (guide)	IV
4.	Project (ME6904D)	Final Presentation and Viva Voce	12	Graded evaluation by a committee of at least two examiners including supervisor (guide) and an external examiner	IV

PROGRAMME EDUCATIONAL OBJECTIVES

I. To achieve competency in the subject domain of advanced computer aided design & manufacturing, rapid product development, robotics, automation & mechatronics, finite element analysis for Mechanical Engineering problems.

II. To implement analytical and computational skills to formulate and solve problems related to thrust area.

III. To carry out research and development activity and recognize the need for lifelong learning with ethical and professional responsibility.

PROGRAMME OUTCOMES:

The students should have –	
PO 1	Ability to apply knowledge to solve complex problems in CAD/CAM & Automation.
PO 2	Ability to design experiments, as well as to analyze and interpret data & results.
PO 3	Ability to design a system/process for sustainability.
PO 4	Ability to communicate effectively and develop leadership skills to function in multidisciplinary teams.
PO 5	Strong desire and ability to do research work.
PO 6	Ability to use and update the techniques, skills, and modern engineering tools necessary for engineering practice.
PO 7	Ability to understand professional and ethical responsibility.

Programme Name	:	M. Tech. (Mechanical) CAD/CAM & Automation	SEMESTER –I
Course Code	:	ME5011S	
Course Title	:	COMPUTATIONAL METHODS	

L	T	P	Credits	TA	IST	ESE	Total
3	-	-	3	20	20	60	100

Outcomes : The students should be able to

1. Solve algebraic equations and Eigen value problems
2. Analyze data using interpolation and regression methods.
3. Apply concepts of vector spaces & different transformation techniques for problem solving.
4. Apply optimization, numerical methods, statistical methods to solve engineering problems

DETAILED SYLLABUS :

Sr. No.	Contents
1	**Algebraic Equations**
	Formulation and solution of linear system of equations
	Gauss elimination
	LU, QR decomposition
	iteration methods (Gauss-Seidal)
	Convergence of iteration methods.-
	Eigen Value problems
2	**Interpolation & Regression Methods**
	Newton’s divided difference
	interpolation polynomials
	Lagrange interpolation polynomials
	Linear and non-linear regression

multiple linear regression

general linear least squares

3 Transform Techniques

Vector spaces, Basis vectors, Orthogonal/Unitary transform, Fourier transform, Laplace transform

4 Optimization Techniques for Engineers

Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function

5 Numerical Methods Chapter

Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rule. Newton Ralphson Method , Numerical differentiation & integration.

6 Statistical Methods

Uncertainty analysis for data reduction ,Data Sampling

Tutorials:

Two tutorials on each module covering relevant engineering applications

Text Books:

01 "Numerical Methods for Engineers', Steven C. Chapra and Raymond P. Canale, McGraw Hill,2008

02 "Probability and Statistics in Engineering and Management Studies", Hines and Montrogmery, John Willey,1990

03 "Numerical Methods for Engineers", Santosh Gupta, New age international publishers,2009

Programme Name	:	M. Tech. (Mechanical) CAD/CAM & Automation				SEMESTER –I	
Course Code	:	ME5021S					
Course Title	:	ROBOTICS					
L	T	P	Credits	TA	IST	ESE	Total
3	-	-	3	20	20	60	100

Outcomes The students should be able to

1. Analyze various types Robots and their applications
2. Perform calculations of Robot kinematics and Robot dynamics.
3. Implement programming for Robot
4. Apply techniques like Robot Vision, Task Planning, Trajectory Planning while performing various types of applications

DETAILED SYLLABUS :

Sr.No.	Contents
1	**Introduction to Robotics** : Automation & Robotics, Robotic Systems & Anatomy of Robot, Classification, Future prospectus
2	**Drive Technologies**: Control loops, Basic control system concepts & models, control system analysis Robot activation & feedback components, position & velocity sensors, Actuators, Power transmission systems.
3	**Robot and its Peripherals**: End effectors- types, Mechanical & other grippers, Tool as end effecter, Sensors: Sensors in robotics, Tactile sensors, Proximity and range sensors, Sensor based system, User vision systems-Equipment
4	**Robot Kinematics** : Forward, Reverse &homogeneos transformations, Manipulator path control, Robot Dynamics.
5	**Robot Vision**: Introduction, Low level & high level vision, Sensing &digitizing, Image processing & analysis, Segmentation, Edge detection, Object recognition & description, Interpretation, Application

6 **Robot Intelligence & Task Planning**: Introduction, State space search, Problem solving, Robot learning, Robot task planning.

7 **Programming for Robots**: Methods, Robot program as a path in space, Motion interpolation, Level & task level language, Robot Languages, Programming in suitable languages, Characteristics of robot.

8 **Robotic Applications in Manufacturing**: Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspections, Robotic cell design & control.

9 **Future Prospects of Robots :**Discussion of Social issues due to developments of Robots, Economics of Robots, Future Scope of Robots.

Text Books:

1 Introduction to Robotics by Saeed B. Niku, John Wiley & Sons, 2nd Edition edition, 2010

2 Robotics Introduction, Programming and Projects by James L. Fuller, Macmillan Publishing Company, New York, 1st edition, 1991.

3 Fundamentals of Robotics by T. C. Manjunath, Nandu Printers & Publishers, Mumbai, 5th edition,2007

Reference Books :

1 Robotics – John Craig. Pearson/Prentice Hall, 3rd edition, 2005

2 Robotics & Control by R.K. Mittal and I. J. Nagrath, Tata McGraw-Hill, New Delhi,2nd edition, 2003

3 Fundamentals of Robotics by Robert Joseph Schilling, Prentice Hall; 1 edition, 1990

4 Robot Manipulators : Mathematics, Programming & Control – Paul R. P. MIT Press,2nd edition 1981

5 Modern Control Engineering –K. Ogata, Prentice Hall, 3rd edition, 1994.

7 Industrial Robotics – Groover and Simmers. Tata McGraw-Hill, New Delhi,2nd edition, 2012

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5022T**					
Course Title	**:**	**Computer Aided Design**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes The students should be able to

1. Evaluate mathematical transformations and projections of rigid bodies.
2. Design & model curves, surfaces & solids.
3. Represent objects realistically.
4. Develop codes to solve engineering problems.

DETAILED SYLLABUS:

Sr. No. **Contents**

Module 1: **Overview of Computer aided Design**
The design process , Computers for design. Hardware & Software requirements in CAD

Module 2: **Overview of Computer Graphics**
Scan conversion algorithms for lines , circle, ellipse and general curves
Line and polygon clipping algorithms with extension to clipping against polygonal and circular window
2D & 3D Transformations: Translation, Rotation, Scaling, Mirror reflection, Shearing Projections: parallel , perspective

Module 3: **Geometric Modeling for Design**
Curves : Explicit, Implicit, Parametric curves. Parametric and Geometric continuity of curves. Hermite, Bezier, B-Spline curves
Surfaces: Planer, Sweep surfaces, Surface of revolution, Bi-linear , lofted, Coon's patch, Hermite, Bezier, B-Spline surfaces

Module 4: **Solid Modeling and Applications**
Introduction, solid representation, B-rep, CSG schemes. Feature Based Modeling.Graphics Standards for Geometric Data Exchange - DXF, IGES, STEP etc

Module 5: Visual Realism

Introduction to hidden data removal: Visibility techniques, Z-buffer, Painter's ,

Area sub division algorithms

Module 6: Develop concepts for Mechanical engineering CAD

Develop Algorithms, Flow Charts and Software for Mechanical Engineering Design Problems

Assignments: Based on the above modules covering relevant engineering applications

Text Books:

01 Computer graphics, Schaum series, McGraw Hill, 2nd edition,2000

02 Mathematical Elements for Computer graphics Rogers & Adams Tata McGraw –Hill, New Delhi, 2nd Edition, 2002

03 Computer graphics- Foley Van Dam, Addision-Wesley, 2nd edition, 1996

04 CAD/ CAM , Theory & Practice. by Ibrahim Zeid, R. Sivasubramanian, Tata McGraw Hill Publications, 5th edition, 2009

05 Computer Graphics. by Donald Hearn and M. Pauline Baker, Eastern Economy Edition-Prentice Hall,3rd edition, 1986

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5022P**					
Course Title	**:**	**Computer Aided Design Lab**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Outcomes The students should be able to

1. Implement various algorithms studied in Computer Graphics
2. Use modern CAD softwares for component modeling and assembly.
3. Develop codes to solve engineering problems.

DETAILED PRACTICALS :

Sr. No.	**Contents**
1	Scan Conversion & Clipping a. Line DDA b. Line Bresenham c. Circle Bresenham d. Mid-point ellipse e. Window Clipping
2	2D & 3D transformations a. Translation b. Rotation c. Scaling d. Shear e. Mirror f. Combination of above

3 Projections (Parallel and Perspective)

4 Curves , Surfaces , Solids

a. Bezier curve
b. B-spline Curve
c. Hermite Curve
d. Lame's Curve
e. Lofted Surfaces
f. Bi-cubic, Bi-quadratic Bezier surface
g. B-spline Surface
h. Coon's Patch
i. Surface through transformations

5 Hidden data removal

6 Component & Assembly modeling using CAD softwares

7 Programs for Mech. Engg. design problems

a. Generation of SFD, BMD
b. Torque diagram of flywheel
c. Cam profile generation
d. Instantaneous center location for slider crank
e. Velocity polygon for slider crank

Practical examination will be based on the above assignments

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5023T**					
Course Title	**:**	**AUTOMATION AND MECHATRONICS**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes The students should be able to

1. Design basic pneumatic circuits
2. Apply assembly programming for 8085 micro-processor and 8051μc.
3. Evaluate PLC for process automation

DETAILED SYLLABUS :

Sr.No.	**Contents**
1	MICROCOMPUTER AND MICROPROCESSOR Introduction To Microcomputer System, Hardware And Software, Introduction To Microprocessor Architecture 8085 And 8086/8088, Control Unit, Memory, Working Register, Internal Clock, I/O Devices And Interfaces, Bus Structure And Its Hardware Connection To Processor.
2	MICROPROCESSOR SOFTWARE Introduction, Data Representation, Binary And BCD Format, Instruction Types, Addressing Modes, Instruction Formats, Instruction Timing And Operations, 8085 Instruction set And Basic Instruction
3	PROGRAMMING Technique, Computer And Timing Delay, Branching, Looping, Stack And Sub Routines

4 HYDRAULIC SYSTEMS

Components And Study Of Simple Hydraulic Circuit, Electro- Hydraulic Systems

5 PNEUMATIC SYSTEMS

Components And Study Of Simple Pneumatic Circuit, Electro- Pneumatic Systems

6 AUTOMATION

Basic Concept, Technique Adopted In Synthesis Of LCA Circuit's And Study Of LCA Component, Case Study Involving Hydraulics In Machine Tool And Automation, Automation In Machining Using Transfer Machines

7 CONTROLLER

Control Theory, Adaptive Controls, PLC In Automation, PID Controller In Automation, Analysis Of Control System Components Such As Valves, Actuators, Transmissions Etc., Dynamic Modeling Of Electro- Pneumatic/ Hydraulic Systems, Study Of Response And Concept Of Stability.

Recommended Text Books

1 Pneumatic& Hydraulic Systems-Aizerman M A,1st Edition,1978

2 Pneumatic Circuits And Low Cost Automation- Fawcett J R, 1st Edition,1985

3 Industrial Hydraulics- Pippenger, 2nd Edition,1992.

4 Computer Numeric Control Of Machine Tool-Thyer G E, 2nd Edition,1986.

Recommended Reference Books

1 Vickers Manual On Hydraulics,2nd Edition ,1985

2 Computer Numeric Control Concept And Programming-Seames W S, 2nd Edition,1996.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5023P**					
Course Title	**:**	**AUTOMATION AND MECHATRONICS LAB**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Outcomes The students should be able to

1. Construct basic pneumatic circuits.
2. Customize assembly programming for 8085 micro-processor and 8051μc.
3. Interface the 8051μc with the apparatus

DETAILED PRACTICALS :

Sr.No.	**Contents**
1	PROGRAMMING: Assembly programming on 8085 for addition, substraction and with carry. Interfacing with the 8051 using ADC,DAC,DC motor.
2	HYDRAULIC SYSTEMS To design the pneumatic circuit for the operation of cascading stage cylinder 3/2-port valves , 5/2-port valves 4-roller valves.
3	PNEUMATIC SYSTEMS To design the pneumatic circuit for the operation of cascading stage cylinder 3/2-port valves , 5/2-port valves 4-roller valves.
6	AUTOMATION:PLC automation using the electropneumatic systems and ladder diagram.Also practicals on ladder simulation software.

7 CONTROLLER :To study the effect of change in the forward path gain N on the system behavior.To study the effect of adding a velocity feedback in addition to the on position feedback on the system behavior.Education servo system ES consisting of I/P and O/P Potentiometers armature controlled DC servomotor, tacho-generator, reduction gear, magnetic Loading device, position and velocity feed-back, CRO etc.

Recommended Text Books

Pneumatic& Hydraulic Systems-Aizerman M A,1st Edition,1978

Pneumatic Circuits And Low Cost Automation- Fawcett J R, 1st Edition,1985

Industrial Hydraulics- Pippenger, 2nd Edition,1992.

Computer Numeric Control Of Machine Tool-Thyer G E, 2nd Edition,1986.

Recommended Reference Books

Vickers Manual On Hydraulics,2nd Edition ,1985

Computer Numeric Control Concept And Programming-Seames W S, 2nd Edition,1996.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5118S**					
Course Title	**:**	**SYSTEM MODELIING AND ANALYSIS**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes

The students should be able to -

1. Model Mechanical, electro-mechanical, hydraulic and pneumatic systems.
2. Estimate and evaluate steady state and transient response for various input conditions.
3. Use numerical and state space approach for finding solutions.

DETAILED SYLLABUS :

Sr. No.	**Contents**
Module 1	**Mathematical Modelling Mechanical Elements** Introduction, Inertia, stiffness and damper and Mathematical Modelling of Mechanical System,Vehicles, Articulated Vehicle and other Mechanical System. Modelling of Electro Mechanical System
Module 2	**The Laplace transform** Introduction, Complex Numbers, Complex Variables, and Complex Functions, Laplace Transformation, Inverse Laplace Transformation, Solving Linear, Time-Invariant Differential Equations
Module 2	**Mathematical Modeling Hydraulic Elements and Systems** Pneumatic Element and System, Transfer Function Representation, Block Diagram, Step variable representation, Matrix Equation.
Module 3	**Numerical and other solution Methods of Differential and step variable equation**

Module 4 **Transient Response of First and Second order system**

Steady State response, Step response, ramp response, Impulse response, sinusoidal response, Input Convolution Integral, Stability of System.

TERMWORK

1. Assignments

2. Seminar

REFERENCE BOOKS

1. Dynamic system Modelling and Analysis-Hung V Vu &R.S.Esfandi,2nd Edition
2. System Dynamics-k.Ogata,4th Edition,Pearson publication.
3. Control SsytemEngioneriing-I.J.Nagrath&M.Gopal,18th Edition,2003
4. System Dynamics-WillianJ.Palm III,2nd Edition
5. Vehicle Dynamics-Ellis,2nd Edition.1969
6. Vehicle Dynamics-Steed,1st Edition,
7. Vehicle Dynamics-Gellips,4th Edition,2000

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5119S**					
Course Title	**:**	**ENERGY CONSERVATION AND MANAGEMENT**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes :

The student should be able to

1. Recognize the concepts of basic measurement, instruments for measuring various parameters in energy systems and energy auditing.
2. Apply Energy Planning and forecasting techniques for performing energy analysis.
3. Illustrate the current energy scenario, challenge of climate change & peak oil, importance of energy conservation and need for alternative energy resources.
4. Integrate energy economics and relevance of sound energy policies for sustainable development.

DETAILED SYLLABUS :

Sr.No. **Contents**

1 INTRODUCTION:

Energy Scenario -world and India. Energy Resources Availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries - an overview.Peak oil. Energy conservation and energy efficiency – needs and advantages.

2 POLLUTION FROM ENERGY GENERATION

Coal and Nuclear based Power Plants – Fly Ash generation and environment impact, Fly ash utilization and disposal, nuclear fuel cycle, radioactive wastes – treatment and disposal-Environmental pollution limits guidelines for thermal power plant pollution control- Environmental emissions from extraction, conversion, transport and utilization of fossil fuels- Green house effect- Global warming.

3 ENERGY AUDITING AND FORECASTING

Energy auditing - Definition, need, types of energy audit methodologies, barriers. Role, Duties and responsibilities of energy managers and auditors. – Energy audit questionnaire - Energy Conservation Act 2003.

Energy forecasting techniques - Energy demand – supply balancing, Energy models, Simulation and forecasting of future energy demand consistent with macroeconomic parameters in India. Basic concept of Econometrics (OLS) and statistical analysis (Multiple Regression), Econometrics techniques used for energy analysis and forecasting with case studies from India.

4 ENERGY CONSERVATION AND MANAGEMENT

Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies for – (a) Thermal utilities: operation and energy conservation (i)Boilers (ii) Thermic Fluid Heaters (iii)Furnaces (iv)Waste Heat Recovery Systems (v) Thermal Storage, A.C. & refrigeration systems; and (b) thermal energy transmission / protection systems such as Steam traps– refractories – optimum insulation thickness– insulation – piping design , optimizing the input energy requirements; Fuel & energy substitution.

5 ENERGY ECONOMICS

Investment - need, appraisal and criteria, financial analysis techniques - break even analysis-simple pay back period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.

6 ENERGY POLICIES

National energy policy in the last plan periods, Energy use and Energy supply, Overview of renewable energy policy and the Five Year Plan programmes, Basic concept of Input-Output analysis, Concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy- Carbon Trading- Renewable Energy Certification – CDM. The Sustainable Energy Utility (SEU) Model.

RECOMMENDED READING :

1. Bent Sorensen, "Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning", Fourth Edition, Academic Press, Elsevier Publication, 2011.
2. Laponche B., Jamet B., Colombier M, Attali S., "Energy Efficiency for a Sustainable World", First Edition, International Council for Energy Publication, Paris, France, 1997.
3. Y. P. Abbi, Shashank Jain, "Handbook on Energy Audit and Environment Management" First Edition, TERI Publications, 2006.
4. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980.
5. YP Abbi and Shashank Jain. “Handbook on Energy Audit and EnviromentManagement”, TERI Publications, 2006.
6. Steve Doty, Wayne C. Tur ENERGY FORECASTING TECHNIQUES.
7. Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com)
8. R Loulou, P R Shukla and A Kanudia, “Energy and Environment Policies for a sustainable Future”, Allied Publishers Ltd, New Delhi, 1997.
9. http://ceep.udel.edu/wp-content/uploads/2013/08/2009_es_BSTS_SEU_model_DE_Wash-DC_Houck_Rickerson_2.pdf.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5120S**					
Course Title	**:**	**RELIABILITY ENGINEERING**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes : The students should be able to -

1. Analyse the interference between strength and stress, or life data for estimating reliability
2. Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects
3. Use statistical tools to characterise the reliability of an item
4. Specify life test plans for reliability validation.

DETAILED SYLLABUS :

Sr. No.	**Contents**
1	Modelling of Life Distribution Functions Quantification of reliability. Parameters of reliability: hazard rate and MTTF (for non-repairable items), failure rate and MTBF (for repairable items). Common failure patterns of systems and components; the bathtub curve for instantaneous failure rates. The memoryless property of items with a constant failure rate. Two- and three-parameter Weibull models.
2	Failure Mechanisms Stress-strength interference as a cause of failure. Approaches to minimise the chance of interference: safety margin, improving process capability, screening of items, and curtailment of load distribution.

3 Modelling of System Reliability

Reliability block diagrams. Series and parallel configurations; use of the Bayesian approach. Use of redundancy to improve reliability. Active and standby redundancies.

4 Reliability Design

Reliability programs. Reliability prediction in the preliminary design stage; the component count approach. Use of the component manufacturer's data and computer packages for reliability prediction. Simplification, derating, and use of redundancy. Fault tree analysis; failure modes, effects, and criticality analysis; development testing; failure reporting and corrective action systems; reliability growth models.

5 Analysis of Life Data and Reliability Testing

Non-parametric estimation of reliability functions. Parametric analysis of life data – probability plots of ungrouped and grouped data. Weibull analysis: parameter estimation, censored data, confidence limits, and Bq life. Hazard plots. Reliability validation tests, MIL-STD-781: the OC curve, discrimination ratio, producer's and consumer's risks. Failure truncation, time truncation, PRST. Confidence intervals for MTBF. Sudden death tests. Environmental testing. Accelerated tests.

TERM WORK

1. Assignments
2. Seminar

REFERENCE

1. Andrew K.S. Jardine and Albert H.C. Tsang, 2013, Maintenance, Replacement and Reliability: Theory and Applications, 2nd edition, CRC Press
2. O'Connor, D.T., 2002, Practical Reliability Engineering, 4th edn, Wiley
3. Elsayed, Elsayed A, 2012, Reliability Engineering, 2nd edition, John Wiley

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5121T**					
Course Title	**:**	**RAPID PRODUCT DEVELOPMENT**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes The student should be able –

1. Analyze and evaluate various existing Product Development processes
2. Develop various Virtual Simulations techniques for industrial applications
3. Develop new technologies in the field Rapid Prototyping & Manufacturing.
4. Generate innovative ideas to reduce time and cost by developing new methods and materials for the modern manufacturing industry.

DETAILED SYLLABUS :

Sr. No.	Contents
1	**Introduction to Rapid Product Development:** Essentials of Good Product Development, Influencing Factors of This Era, Types of Businesses, Product & Its classification, Product Cycle, Groupings of Activities, Bottlenecks in Product Development, An Overview of Rapid Product Development (RPD)
2	**Virtual Reality :** Introduction to Geometric Modeling, Types of Geometric Modeling, Features of Wireframe, Surface and Solid models, Definition of VR , Features of VR, Real time Response, Optimization of the Rendering Process, Technologies used in VR, Stereo Displays,Interactions in VR, Tracking based interaction, Data Generation for VR, Haptic Rendering, Applications of VR, Simulation in VR, Augmented Reality.

3 **Virtual Prototyping & Manufacturing**

Introduction to CNC, Applications of CNC, Advantages and Limitations of CNC, Introduction to Virtual Prototyping & Manufacturing, Objectives of VP&M, Benefits of VP&M, Tools for VP&M, Applications of VP&M, Virtual Machining (VM) or Volumetric NC Simulation (VolSIM), Conventional NC Simulation Systems, Volumetric NC Simulation System, Applications of Volumetric NC Simulation System, Important issues in VolSIM, Architecture of a Volumetric NC Simulation System, Offline Adaptive Control.

4 **Rapid Prototyping :**

Rapid PrototypingDefinition, Principle of RP, Comparison of CNC and RP, RP Processes like, Laminated Object Manufacturing(LOM), *OptiLOM* (Optimization OF LOM), Fused Deposition Modeling (FDM),Stereo-lithography Apparatus(SLA), Photo-masking or Solid Ground Curing (SGC), Objects, Perfactory, Selective Laser Sintering (SLS), 3DPrinting (3DP), Applications/ Case studies/ Advantages, Important Issues in RP,

5 **Rapid Tooling :**

Types of objects, Virtual Objects, Physical Objects, Types of approaches: Layered Manufacturing and Material Translation,Need for Rapid Tooling & Metallic/ Ceramic Prototyping, Conformal Cooling Channels, Various types of tools- Metallic and Non-metallic tools, Direct and Indirect Methods of Rapid Tooling. Applications of Rapid Tooling.

6 **Reverse Engineering :**

Need for Reverse Engineering, Digitizing Methods and its Principles,Types measurements, Contact & Non-contact Types, Coordinate Measuring Machine (CMM),Capture devices, Sensors, Scanning Methods, Data representation, Data processing and manipulation techniques. Applications

7 **Polyhedral Modeling :**

Introduction,Types of CAD formats, IGES Format, Possible defects in IGES files, STL Format, Possible Defects in STL Files, Polyhedral B-Rep Kernel, Repairing STL Files, Repairing Missing Faces, Repairing Flipped Faces, Slicing and Other Operations, Feature Recognition from STL Files, Curvatures of Polyhedral Objects.

8 Introduction to Rapid Prototyping, Definition of Rapid Manufacturing, Roadmap to Rapid Manufacturing, Comparison of Various Processes for Rapid Manufacturing of Metallic Objects, Rapid Manufacturing of Polymeric Objects, Rapid Casting, other RM Processes like Hybrid Layered Manufacturing, Material

Translation using Segmented Object Manufacturing.

9 **Synergic Integration :**
Introduction to Concurrent Engineering, Methodology of Concurrent Engineering, Integration in Concurrent Engineering,, Benefits of Concurrent Engineering, Introduction to Product Data Management, Product Data Classification, Process Maagement, Benefits of PDM, Introduction Product Life Cycle Management, Evolution and Components of PLM, Case Studies/Applications.

Text Books:

1 Rapid Product Development & Manufacturing by K.P.Karunakaran, IIT, Bombay, 1st edition, 2013

2 Virtual Reality by Ken Pimentel, Kevin Teixeira, Windcrest McGraw-Hill, 1st edition 2003

3 Rapid Prototyping Principles and Applications by RafiqNoorani, John Wiley & Sons -1st edition, 2006.

Reference Books :

1 Rapid Manufacturing , An Industrial Revolution for the digital age by N.Hopkinson, R.J.M.Hague -2nd edition, 2006.

2 User's Guide to Rapid Prototyping, By Todd Grimm, Society of Manufacturing Engineers, 1st edition, 2004

3 Rapid Tooling: Technologies and Industrial Applications by Marcel Dekker. Peter D. Hilton and Paul F. Jacobs (Ed.),4th edition, 2000.

4 Virtual Reality Systems by John Vince, Addison-Wesley, 1st edition-1995.

5 Rapid Prototyping by Andreas Gebharatdt, Hanser Publishers, 2nd edition – 2003

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –I**	
Course Code	**:**	**ME5121P**					
Course Title	**:**	**RAPID PRODUCT DEVELOPMENT LAB**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Outcomes: The students should be able to -

1. Develop 3D models, assemblies and detailed 2D drawings
2. Build ‘stl’ files from 3D models
3. Build rapid prototyping parts
4. Apply surface finish enhancement techniques on FDM parts.

DETAILED PRACTICALS :

Sr. No.	**Contents**
1	INTRODUCTION TO Creo a. What is a CAD software b. CAD software types and levels c. What is Creo d. Specialities and scope of Creo
2	SKETCHER MODULE a. Introduction to sketcher module b. Creating a new sketch c. Setting up the unit system d. Introduction to sketcher menus and toolbars e. Details of various sketcher commands f. Drawing curves and 2-D sketches

3 3D PART MODELLING

a. Introduction to solid part module

b. Details of commands being used for 3D modeling.

i. Extrude

ii. Revolve

iii. Fillet

iv. Chamfer

v. Hole

vi. Pattern

vii. Mirror

viii. Dimensioning

ix. Modification

x. Regeneration

xi. Cross-section

xii. Adjusting views

xiii. Switching between units

4 ASSEMBLY

a. Introduction to assembly module

b. Calling the components

c. Assembling the components

d. Taking sections across assembly

e. Modifying a component/s during process

f. Mechanism simulation

5 DRAFTING

a. Introduction to drafting module
b. Generating templates, tables etc.
c. Calling the object/assembly
d. Setting the views
e. Generating cross-sections
f. Generating BOM (Bill Of Materials), in case of assembly drafting
g. Converting the draft file to corresponding pdf format

6 BUILD THE '.stl' FILE

a. Introduction to 'STL' and other tessellation file formats.
b. Details of 'STL' files
c. Converting a Creo file to '.stl' file format

7 BUILDING PARTS ON 'Rapid Prototyping' MACHINE

a. Introduction to the existing RP machine in the lab
b. Introduction to corresponding controlling software
c. Importing a '.stl' file to this software
d. Adjusting various parameters
e. Printing the parts on RP machine

8 WORK ON POSTPROCESSOR

a. Details of postprocessor in the lab
b. Removing support material of printed RP parts

9 MEASUREMENT OF SURFACE ROUGHNESS OF 'RP' PARTS

Assignments based on above topics/practicals. Practical Examination will be based on tool path generation for the given component using the CAM software.

Programme Name	:	M. Tech. (Mechanical) CAD/CAM & Automation				SEMESTER –II	
Course Code	:	ME5024S					
Course Title	:	ADVANCED MANUFACTURING PROCESSES					
L	T	P	Credits	TA	IST	ESE	Total
3	-	-	3	20	20	60	100

Outcomes: The students should be able to

1. Identify various manufacturing processes and their defects and failure mechanisms.
2. Analyze casting processes and welding process and their significance.
3. Select appropriate processes for specific requirements.
4. Analyze effect of parameters on properties of casting /welding.

DETAILED SYLLABUS :

Sr.no	Contents
1	Principles of Casting – metals, alloys eutectics and plastics; Mechanism of melting and solidification, grain growth and structure, shrinkage defects.
2	Mold filling – fluidity and turbulence, filling under gravity and pressure; filling defects; gating design, injection Molding, Simulation of Mold filling and Solidification.
3	Fundamentals of fusion welding processes – analysis of heat source, types of metal transfer, weld pool characteristics, solidification mechanisms in fusion zone, heat affected zone characteristics, types of weld joint, distortion and residual stresses, weld defects, destructive and non-destructive testing of welds.
4	Principles of Brazing and Soldering, Semi-solid and Solid state Joining processes, Friction Stir welding process; Introduction of joining of non-metallic materials.
5	Principles of ECM, EDM and laser cutting.

References:

1. Cambell, J., Casting, Oxford: Butterworth Heinemann, 1st edition, 2003.
2. Messler, R. W., Principles of Welding, John Wiley & Sons, 1st edition, 1999.
3. Heine, R. W., Loper, C. R. and Rosenthal, Principles of metal casting, Tata McGraw Hill, New Delhi, 2nd edition, 1991.
4. Lancaster J. F. (ed.), Physics of welding, Oxford: Pargamon Press, 1st edition, 1986.
5. Pye, R. G. W., Injection mold design: a design for the thermoplastic industry, London: George Godwin, 1st edition,1983.
6. Houldcorft, P. T., Welding process technology, Cambridge University Press, 2nd edition, 1985.
7. Lancaster, J. F., Metallurgy of welding, brazing and soldering, George Allen & Unwin, London, 1st edition, 1985.

Programme Name	:	M. Tech. (Mechanical) CAD/CAM & Automation				SEMESTER –II	
Course Code	:	ME5025T					
Course Title	:	COMPUTER INTEGRATED MANUFACTURING					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes : The student should be able –

1. Analyze various existing manufacturing processes.
2. Develop various Automation strategies for industrial applications using Flexible Manufacturing Systems.
3. Apply new technologies like G.T., MRP, ERP in the field Manufacturing.
4. Integrate the Manufacturing Systems with Manufacturing Support systems through Computer networking and Computer database.

DETAILED SYLLABUS :

Sr. No.	Contents
1	**Introduction to Computer Integrated Manufacturing:** Evolution of C.I.M., CIM Hardware and Software, Role of elements in CIM, Product development through CIM. Production System Facilities, Manufacturing Support Systems, Automation Principles and Strategies.
2	**Manufacturing Operations:** Manufacturing Industries and Products, Manufacturing Operations, Cost of Manufacturing Operations
3	**Introduction to Automation:** Basic Elements of an Automated System, Advanced Automation functions, Levels of Automation
4	**Industrial Robotics:** Sensors, Actuators, Robot Anatomy and related attributes, Robot Control Systems, End Effectors, Industrial Robot Applications
5	**Computer control of machine tools :** Fundamentals of CNC machine tools, Programming of CNC machines, Tool path generation, Direct Numerical Control.

6 **Manufacturing Systems**

Fundamentals of Manufacturing systems, Group Technology, FMS, Transfer lines, Manual & Automated Assembly systems, Analysis of Manufacturing systems, Simulation of Manufacturing systems, Automated Material handling systems

7 **Information System and Manufacturing**

Manufacturing resources planning, Role of MRP-II in CIM system, Enterprise Resources Planning, Supply chain management, Virtual Manufacturing.

8 **Computer Aided Inspection Technologies**

Inspection principles, Coordinate Measuring Machine, Non-contact Inspection Methods, Integrated Computer aided inspection systems.

9 **Computer Networking :**

CIM models, Fundamentals of networking, Shop floor data control, CIM database and CIM database requirements

Text Books:

1 Automation, Production systems and Computer Integrated Manufacturing, M. P. Groover, Prentice Hall, New Delhi, 3rd edition, 2007

2 CAD/CAM/CIM – P. Radhakrishnan and S. Subramanyan, New Age International Publishers, 2nd edition, 2008

Reference Books :

1 CAD/CAM by P.N.Rao, Tata McGraw Hill Publications, 3rd edition, 2010.

2 Fundamentals of CIM Technology – Oavid I. Geotsch, Delmar Publishers,1st edition, 1988

4 Computer Control of Manufacturing systems by YoramKoren, McGraw Hill, 1st edition, 1983

5 Numerical Control and Computer Aided Manufactureby T. K. Kundra, P. N. Rao, N. K. Tewari, Tata McGraw Hills, New Delhi., 1st edition, 1985

6 Principles of Computer Integrated Manufacturing by S Kant Vajpayee, Prentice Hall, New Delhi,1995

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –II**	
Course Code	**:**	**ME5025P**					
Course Title	**:**	**COMPUTER INTEGRATED MANUFACTURING LAB**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Outcomes : The student should able to

1. Develop CNC tool path from 3D models
2. Generate part programs
3. Machine the parts using CNC machine
4. Perform inspection of parts using CMM machine

DETAILED PRACTICALS :

Sr.No. Contents

1. Tool path generation using CAM software
    a. Introduction to 'DelCAM' software
    b. Importing and modifying 3D geometry
    c. Selecting tools
    d. Generating operation specific tool path
    e. Generating G-codes and M-codes in 'DelCAM' software
2. CNC part programming on CNC machine
    a. Introduction to existing CNC machine in the lab
    b. Introduction and details of its corresponding control software
    c. Machining parts, as per given drawings

3. Using Coordinate Measuring Machine.
    a. Demonstration on existing CMM machine
    b. Introduction and details of controlling software
    c. Measuring various components
4. Case study on software used for integration in manufacturing
5. Case study on use of software for simulation of manufacturing system

Practical Examination will be based on tool path generation for the given component using the CAM software.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –II**	
Course Code	**:**	**ME5026T**					
Course Title	**:**	**FINITE ELEMENT METHODS**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes: The student should be able to

1. Formulate numerical model for a given system.
2. Obtain numerical solutions for boundary value problems.
3. Solve mechanical engineering problems using FEA techniques.

DETAILED SYLLABUS :

Sr.No.	**Contents**
Module 1	**Introduction to Finite Element Analysis** Introduction, Basic concept of Finite Element analysis, Discretization of continuum, Stiffness Matrix and Boundary Conditions, Introduction to elasticity ,Plane Stress and Plain strain Problem
Module 2	**Finite Element Formulation Techniques** Virtual Work and variational principle, Variational Formulation of Boundary Value problem, Variational Method such as Ritz and weighted Residual methods. Galerkin Method Potential Energy Approach, Displacement Approach
Module 3	**Element Properties** Natural coordinates, Triangular Elements Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements Isoparametric Formulation Stiffness Matrix for Isoparametric Elements, Numerical Integration
Module 4	**Displacement Models** Convergence requirements, Shape functions, Element stresses and strains Strain—Displacement Matrix for Bar Element ,Strain Displacement Matrix for CST Element ,Strain Displacement Relation for Beam Element

Module 5 **Analysis of Frame Structure**

Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members

Finite Elements analysis of Beam

Module 6 **FEM for Two Dimensional Solids**

Constant and Linear Stain Triangle.

Rectangular Elements, Finite Element Formulation for 2D elements.

Axisymmetric Elements. Finite Element Formulation of Axisymmetric Elements

Heat Transfer by conduction and convection for one dimensional and two dimensional elements.

Module 7 **Dynamic Analysis Using FEA**

Introduction, Vibration Problems

Equation of motion Based on weak form and Lagrange's Approach, Consistent and Lumped ass Matrices, Properties and Solution of Eigen Value Problems

Transient Vibration Analysis ,Thermal transient-Unsteady heat Transfer in a Pin-Fin

Module 8 **Non Linear Analysis**

Introduction, Geometric and Material Non Linearity, Stability Problems

Elastoplastic analysis by FEM

TERMWORK

1. Assignments
2. Seminar

REFERENCE BOOKS

1. Finite Elemenet Analysis By S.S.Bhavikatti,New Age International Publication,2 nd Edition
2. Introduction to FEM by Desai and Abel,2nd Edition
3. The Finite Element Method for Solid and Structural Mechanics - Zienkiewicz & Taylor,Elsevier Publications ,6th Edition ,2005
4. Finite Element Analysis by J.N.Reddy,McGraw Hill Book Co.6th Edition 2010
5. Finite Element Method in Engineering by S.S.Rao,4th Edition, Dec 2004, Pergamon Press
6. Textbook on Finite Element Analysis by P.Sheshu,1st edition, Prentise Hall Publications
7. Finite Element Analysis By Bathe and Wilson,4th Edition 2010,Prentice Hall Publication

8. Introduction to Finite Element Analysis by T. Chandrupatla and A. D. Belegundu, 3rd Edition,Prentice Hall
9. Finite Element Modeling For Stress Analysis for Robert D.Cook , 4th Edition John Wiley & Sons.
10. Computational Elasticity by Mohammad Ameen, Narosa Publishing House.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –II**	
Course Code	**:**	**ME5026P**					
Course Title	**:**	**FINITE ELEMENT METHODS LAB**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Course Outcome: The student should be able to

1. Use commercial FEA software, to solve problems related to mechanical engineering.

DETAILED PRACTICALS :

Assignment No.	Topic
	Structural Analysis
1	1-D Element Problems –Linear Static Analysis
2	2-D Element Problems – Linear Static Analysis
3	3-D Element Problems – Linear Static Analysis
4	Free Vibration Analysis on Beam, Bars ,Plates
5	Non-Linear Analysis of 1-D Element Problems Like Beams,Bars
	Thermal Analysis (Conduction,Covection and Insulation Boundary Conditions.
6	1-D Element Problems-Steady state And Transient Analysis
7	2-D Element Problems of Homogeneous and Composite Slap in Steady State and Transient Analysis
8	3-D Element Problems Steady State Analysis
9	Project-Creating or Importing and Map Meshing of 3-D component /Assembly of practical application and FEA Analysis of Same component /Assembly

Note:-

Well Reputed FEA software like HyperMesh /Ansys Will be used for the above mentioned Assignments.

Assesement:-

1.Term work Assesment based on the submission (Softcopy and Hard Copy) of the above assignment

2.ESE (Practical Examination)Will be online type based on the Application of above assignment using HyperMesh /AnsysSoftwares.

Reference Material:

1. Finite Element Analysis using Ansys 11.0 by PaletiShrinivas,KrishaChaitnay

Sambana, Rajesh Kumar Datti.,1 st Edition,2010

2. Finite Element Analysis Theory and Applications with ANSYS by Saeed

Moaveni,Prentice Hall Publication,2Nd Edition,2000

3. Engineering Analysis with ANSYS Software by Y. Nakasone and S.

Yoshimoto,1st Edition,2006

4.The finite element method And applications inEngineering using ansys®by

ErdoganMadenci,IbrahimGuven,Springer Publication, 1st Edition,2006

5. Practical Finite Element Analysis by NitinGokhale of M/s Finite to Infinite.,3rd Edition,2010

6. Reference Manual of Hypermesh Software

7. Online Tutorial HyperMesh Software.

8. Tutorial of Ansys Software.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –II**	
Course Code	**:**	**ME5133S**					
Course Title	**:**	**PRESSURE VESSEL DESIGN**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes : Students should be able to –

1.Design pressure vessels subjected to internal and external pressure.

2. Evaluate the effect of other requirement like wind load, seismic load, etc.

3. Select appropriate material as per the working conditions.

4. Examine the requirements of transportation, Testing and erection of vessel.

DETAILED SYLLABUS :

Sr. No.	Contents
1	Introduction to P.V. & Review of P.V. Codes
2	Theory of P. V. Design
3	Selection of material for Pressure vessel, ASME Material codes for P.V.
4	Design of Shell / Head for Internal Pressure & Examples
5	Design of Shell / Head for External Pressure & Examples
6	Understanding Requirements of Part UG, UW, UCS of ASME Sec VIII Div 1 & Examples
7	Design of Nozzles & Examples
8	P V Design for External load – Wind/ Seismic & Support Design & Examples
9	Design of Flanges & examples

10 Use of PV Elite software

11 Evaluation of P V for various conditions like lifting, transportation, Hydro test etc.

12 Combination of creep-fatigue, creep bucking on P V

Reference Books

1. "Pressure vessels design and practice", By: SomnathChattopadhyay. Publication: CRC Press. Ed: 2005
2. "Overview of pressure vessel design", By: Vincent A. Carucci. Publication: ASME International
3. "Process equipment design", By: Brownell and Young. Publication: Wiley Eastern Limited. Ed:1959, sixth reprint Sept 1991.
4. "Review of code for pressure vessels, IS 2825 as compared to ASME/BS/ADMerkblatter",

   By: N K Roy. Publication: Journal for Process Equipment & Piping Technology. Vol 1, No 1, June 1994
5. "A special report : Worldwide pressure vessel codes". Publication: Hydrocarbon Processing, Dec 1978. ASME Section VIII Div-1, 2 & 3 Ed. 2010 Addenda 2011a.
6. "Theory & Design of Pressure Vessels", By: John F Harvey, 15th Edition, Van Nostrand Reinhold Company Ltd.
7. "Pressure Vessel Design Handbook" By H. Bedner
8. Pressure Vessel Design Manual – Dennis Moss

Programme Name	:	M. Tech. (Mechanical) CAD/CAM & Automation	SEMESTER –II
Course Code	:	ME5122S	
Course Title	:	PROCESS EQUIPMENT DESIGN	

L	T	P	Credits	TA	IST	ESE	Total
3	-	-	3	20	20	60	100

Outcomes : Students should be able to

1. Design internal pressure vessels subjected to internal and external pressure.

2. Design special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads)

3. Examine other requirements of equipment fabrication and testing

DETAILED SYLLABUS :

Sr. No.	Contents
1	Type of vessels and factors influencing the design of vessels. classification of vessels such as tank, flat, bottomed and vertical cylinder tank, vertical cylindrical and horizontal vessels with formed ends as well as spherical or modified spherical vessels.
2	Criteria in vessel design. Elastic bending, plastic instability, cyclic loading stress reversals. Brittle rupture and creep rupture corrosion.
3	Design of simple vessels of different configuration. General proportions and lay-out. Vents, tapping and flanges.
4	Design of tall vertical vessels and supports
5	Elementary heat exchanger design.

Term work

1. Assignment
2. Seminar

Reference Books

1. “Pressure vessels design and practice”, By: SomnathChattopadhyay. Publication: CRC Press. Ed: 2005
2. “Overview of pressure vessel design”, By: Vincent A. Carucci. Publication: ASME International
3. “Process equipment design”, By: Brownell and Young. Publication: Wiley Eastern

   Limited. Ed:1959, sixth reprint Sept 1991.
4. “Review of code for pressure vessels, IS 2825 as compared to ASME/BS/ADMerkblatter”, By: N K Roy. Publication: Journal for Process Equipment & Piping Technology. Vol 1, No 1, June 1994
5. “A special report : Worldwide pressure vessel codes”. Publication: Hydrocarbon
6. Processing, Dec 1978.
7. ASME Section VIII Div-1, 2 & 3 Ed. 2010 Addenda 2011a.
8. “Theory & Design of Pressure Vessels”, By: John F Harvey, 15th Edition, Van Nostrand Reinhold Company Ltd.
9. “Pressure Vessel Design Handbook” By H. Bedner
10. Pressure Vessel Design Manual – Dennis Moss

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –II**	
Course Code	**:**	**ME5127T**					
Course Title	**:**	**ADVANCE MACHINE DESIGN**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
3	-	-	3	20	20	60	100

Outcomes The students should be able to -

1. Apply re-engineering practices.
2. Employ reverse engineering process
3. Carry out design of experiments & Taguchi method
4. Demonstrate robust design principles

DETAILED SYLLABUS :

Sr. No.	Contents
1	**Uncertainty, Statistical Tools and Techniques of handling Uncertainty.** The Mystique of Probability, Idea of a Random Variable ,`Hypothesis Testing': , Comparing Two Population, Cause-Effect Models and Regression ,"Cause" Factor, F-Statistic , The Mean Sum of Squares
2	**Design Process.** Re-engineering, Reverse Engineering of Design, Concurrent Engineering
3	**Design Of Experiment**. One-Factor Designed Experiment, ANOVA Helps Compare Variability , Factor Effects are Statistically Significant ,Sum of Squares and the F-Test
4	**Taguchi Method** Design Achieving Quality—Taguchi's Seven Points Optimized Design, Reduces R&D, Production, and Lifetime Cost. Taguchi's Definition of Quality ,Causes Performance ,Prevention by Quality Design Steps in Designing Performance into a Product Functional Design, Parametric Design, Additivity, the Response table,
5	**Signal to Noise Ratio** Selecting Factors for Taguchi Experiments Seek Robustness One Should Measure Performance by S/N Ratios, S/N Ratio in Optimization, OA as the Experiment Matrix, Axiomatic Approach to Design

6 **Orthogonal Arrays**
Orthogonal Arrays , Control and Noise Factors: The Ishikawa Diagram , Optimized Design , Testing for Additivity, The Optimization Strategy , Taguchi's Two Steps to On-Target Performance with Minimum Variability

7 **Process/ Product Optimization.**
Passive Network filter, Formal Statement of the Design Problem, Robust Design Formulation of the Problem, Data Analysis and Estimation of Effects , Effects of the Design Parameters, The Process for Manufacturing Optical Filters , Control Parameters and the OA Performance Measurements and the S/N Ratio Minimizing log10 (s2), Variability of Thickness.

8 **Robust Design**
Re-Statement of the Multiple Objective Design Optimization , Target Performance Requirements as Explicit Constraints ,Constraints Present in the Filter Design , Seeking Pareto-Optimal Design, Monte Carlo Evaluation of S/N Ratios, Necessary Mathematical Tools, Developing a Multiple Regression Model, Rationale of the Constrained Robust Design Approach, Application of the Constrained Approach to Real, Discussion of the Constrained Design Optimization

9 **Loss function and Design Tolerances.**
Loss to Society is More Than Defective Goods, Determining Manufacturing Tolerances , Loss Functions for Mass-Produced Items

TERM WORK

1 Assignments based on above topics
2 Case studies
3 Seminars

REFERENCES

1 Tapan P. Bagchi; Taguchi Method Explained, PHI, New Delhi, 1st ed, 1993
2 Suh Nam P.; the Principles of Design, Oxford university Press, NY, 1st ed, 1990
3 Hammer Michel, Champy J. ; Re-engineering the Corporation, Nicholas Brealey publishing , London.

Programme Name	**:**	**M. Tech. (Mechanical) CAD/CAM & Automation**				**SEMESTER –II**	
Course Code	**:**	**ME5127P**					
Course Title	**:**	**ADVANCE MACHINE DESIGN LAB**					
L	**T**	**P**	**Credits**	**TA**	**IST**	**ESE**	**Total**
-	-	2	1	50	-	50	100

Outcomes The students should be able to

1. Design experiment for process/product optimization.
2. Apply Taguchi method for optimization.
3. Perform S/N analysis for optimization.

DETAILED PRACTICALS :

Process/ Product Optimization

Case studies

Design Of Experiment in Vibration of Bearing

Taguchi Method For optimization of parameters

Signal to Noise Ratio for optimization

Design Of Experiment in Fault Diagnosis Of machine