**VelagapudiRamakrishna SiddharthaEngineeringCollege:Vijayawada-7**

**SchemeofInstructionandExamination– VR14**

**Departmentof MechanicalEngineering**

**Semester VII**

| S.No | Sub. Code | Subject Title | L | T | P | C | CE | SE | T |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 14ME3701 | Finite Element Method | 4 | 1 | | 4 | 30 | 70 | 100 |
| 2 | 14ME3702 | Computer Aided Manufacturing | 4 | | | 4 | 30 | 70 | 100 |
| 3 | 14ME3703 | Refrigeration and Air Conditioning | 4 | | | 4 | 30 | 70 | 100 |
| 4 | 14ME4704 | Program Elective – I | 3 | 1 | | 3 | 30 | 70 | 100 |
| 5 | 14ME4705 | Program Elective – II | 3 | 1 | | 3 | 30 | 70 | 100 |
| 6 | 14ME3751 | Heat Transfer Lab | | | 3 | 2 | 30 | 70 | 100 |
| 7 | 14ME3752 | Design and Metrology Lab | | | 3 | 2 | 30 | 70 | 100 |
| 8 | 14ME6753/ 14ME6754 | Internship/ | -- | | 4 | 2 | -- | 100 | 100 |
| | | Industry offered Course | 2 | | -- | | | | |
| 9 | 14ME5755 | Mini Project | | 2 | | 2 | 30 | 70 | 100 |
| **Total** | | | **18/ 20** | **5** | **10/ 6** | **26** | **240** | **660** | **900** |

L – Lecture, T – Tutorial, P – Practical, C – Credits, CE - Continuous Evaluation, SE - Semester End Evaluation, T – Total Marks

ELECTIVE– I:

ME 4704/1 :Mechatronics

ME 4704/2 :Computational Fluid Dynamics

ME 4704/3 : Hydraulic and Pneumatic Systems

ME 4704/4 : Reliability Engineering

ME 4704/5 :Optimization Techniques

ELECTIVE– II:

ME 4705/1 :Computer Aided Design

ME 4705/2 :Design for Manufacturing & Assembly

ME 4705/3 :Mechanical Vibrations

ME 4705/ 4 :Signal Analysis and Condition Monitoring

ME 4705/5 :Product Design and Development

**VelagapudiRamakrishna SiddharthaEngineeringCollege:Vijayawada-7**
**SchemeofInstructionandExamination– VR14**
**Departmentof MechanicalEngineering**
**Semester VIII**

| S.No | Sub. Code | Subject Title | L | T | P | C | CE | SE | T |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 14ME 3801 | Manufacturing Management | 4 | | | 4 | 30 | 70 | 100 |
| 2 | 14ME 4802 | Program Elective - III | 3 | 1 | | 3 | 30 | 70 | 100 |
| 3 | 14ME 4803 | Program Elective - IV | 3 | 1 | | 3 | 30 | 70 | 100 |
| 4 | 14ME3851 | Computer Aided Engineering Lab | | | 3 | 2 | 30 | 70 | 100 |
| 5 | 14ME 5852 | Major Project | 2 | 6 | 10 | 10 | 30 | 70 | 100 |
| | | Total | **12** | **8** | **13** | **22** | **150** | **350** | **500** |

L – Lecture, T – Tutorial, P – Practical, C – Credits, CE - Continuous Evaluation, SE - Semester End Evaluation, T – Total Marks

ELECTIVE– III:

ME 4802/1 :Robotics

ME 4802/2 :Flexible ManufacturingSystems & Group Technology

ME 4802/3 :Advanced Manufacturing Management

ME 4802/4 :Machine Tool Design

ME 4802/5 :Advanced Manufacturing Processes

ELECTIVE– IV:

ME4803/1 : Energy Conversion & Management

ME4803/2 : Automobile Engineering

ME 4803/3 :Cryogenic Engineering

ME 4803/4 :Gas Dynamics

ME 4803/5 :Solar Energy Utilization

## 14ME 3701 - FINITE ELEMENT METHOD

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|---|---|---|---|
| **Course Category:** | Program Core | **Credits:** | 4 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practice:** | 4 - 1 - 0 |
| **Prerequisites:** | 14ME3302 Mechanics of Materials<br>14ME3402Advanced Mechanics of Materials<br>14ME3601 Heat Transfer | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

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| **Course outcomes** | | After successful completion of this course, the student will be able to | | | | | | | | | | | |
| | **CO1** | Understand the philosophy of FEM and solve 1-D bar problems (a,c,e,k) | | | | | | | | | | | |
| | **CO2** | Understand finite element formulation for planar truss, beam and frame problems (a,c,e,k) | | | | | | | | | | | |
| | **CO3** | Apply FEM to 2-D plane-stress, plane-strain and axisymmetric problems, and perform 1-D numerical integration (a,c,e,k) | | | | | | | | | | | |
| | **CO4** | Apply FEM to 1-D steady state heat transfer and understand FE formulation for free vibrations of 1-D problems (a,c,e,k) | | | | | | | | | | | |
| **Contribution of Course Outcomes towards achievement of Program Outcomes (L–Low, M-Medium,H-High)** | | POa | POb | PO c | POd | PO e | PO f | POg | PO h | PO i | PO j | PO k | PO l |
| | **CO1** | M | | L | | H | | | | | | M | |
| | **CO2** | M | | L | | H | | | | | | M | |
| | **CO3** | M | | L | | H | | | | | | M | |
| | **CO4** | M | | L | | H | | | | | | M | |

**Course Content**

**UNIT I:**

**Fundamental Concepts**: Introduction, stresses and equilibrium, boundary conditions, strain-displacement relations, stress-strain relations for plane stress, plane strain, 2-D axisymmetric and three-dimensional cases, potential energy and equilibrium; the Rayleigh-Ritz method, Galerkin's method.

**Basic Concepts of F.E.M. and One Dimensional Problems :** Fundamental concepts, Finite Element Modeling, Coordinates and Shape functions, The Potential Energy Approach, Stiffness Matrix and Load Vector, Assembly of the global stiffness matrix and load vector, Properties of global stiffness matrix, The Finite Element equations; Treatment of boundary conditions, Examples of Axially Loaded Members, Quadratic shape functions, Temperature effects.

**UNIT II:**

**Analysis of Plane Trusses**: Introduction, Plane Trusses, Local and Global Coordinate systems, Element Stiffness Matrix, Treatment of boundary conditions, Stress Calculations, Example of plane Truss with three members.

**Analysis of Beams and Frames**: Introduction, Potential Energy Approach, Element

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| | stiffness matrix for two node planar beam element, load vector, boundary conditions, simple beam problems.Stiffness matrix of two node planar frame element.<br><br>**UNIT III:**<br>**Two Dimensional Problems**: Introduction, Plane Stress and Plane Strain, Finite Element Modeling, Constant Strain Triangle (CST); Potential Energy Approach, derivation of Element Stiffness matrix, derivation of force vector for body forces and linearly varying pressure load, Problem modeling and boundary conditions.<br><br>Finite element formulation for an axisymmeric linear triangular element, Derivation of element stiffness matrix, derivation of force vector for body forces and uniformly distributed pressure load. Concepts of isoparametric, subparametric and superparametric elements, Numerical integration: One-dimensional Integrals using one-point formula, One-dimensional Integrals using two-point formula.<br><br>**UNIT IV**:<br>**One-Dimensional Steady State Heat Transfer Analysis**: Introduction, One dimensional steady state heat conduction, boundary conditions: specified temperature, convection and heat flux, Galerkin's approach for heat conduction, One dimensional heat transfer in thin fins.<br>**Free Vibration Analysis:** Hamilton's principle, solid body with distributed mass, derivation of element mass matrix: linear one-dimensional bar element, truss element, beam element, Evaluation of eigenvalues and eigenvectors, Natural frequencies of a stepped bar with one end fixed and other end free boundary conditions. |
| **Text Books and Reference Books** | **Text Books:**<br>1. Introduction to Finite Elements in Engineering by T. R. Chandrupatla and A. D. Belegundu, 3rd Edition, PHI Learning Private Limited, 2011.<br><br>**Reference Books:**<br>1. Singiresu S. Rao, "The Finite Element Method in Engineering", Fifth edition, Butterworth-Heinemann, 2011.<br>2. An introduction to the Finite element method by J. N. Reddy, 2nd edition, TataMcgraw-Hill, 2004.<br>3. Cook, Robert Davis et al, "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 4th Edition, 2007.<br>4. Finite Element Analysis by P. Seshu, PHI Learning Private Limited, 2008. |
| **E-resources** | 1. https://en.wikipedia.org/wiki/Finite_element_method<br>2. http://reference.wolfram.com/applications/structural/FiniteElementMethod.html<br>3. https://www.youtube.com/watch?v=oNqSzzycRhw<br>4. https://www.youtube.com/watch?v=NYiZQszx9cQ&list=PLA4CBD0C55B9C3878 |

## 14ME 3702 - COMPUTER AIDED MANUFACTURING

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| **Course Category:** | Program Core | **Credits:** | 4 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practice:** | 4 - 0 - 0 |
| **Prerequisites:** | 14ME1107- Mechanics for Engineers<br>14ME3507–Metal Cutting and Machine Tools | **Continuous Evaluation:**<br>**Semester End Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

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| **Course outcomes** | Upon successful completion of the course, the student will be able to: | | | | | | | | | | | | |
| | CO1 | Understand the concepts of NC machine tools, their classification, applications, Advantages & Disadvantages (a,c) | | | | | | | | | | | |
| | CO2 | Understand the concepts of CNC, DNC, Adaptive control and Manual part programming (a,c) | | | | | | | | | | | |
| | CO3 | Understand the fundamentals of A P T Language and Group Technology (a,c,e,k) | | | | | | | | | | | |
| | CO4 | Understand the concepts of Computer Aided Process Planning, Flexible Manufacturing Systems, their applications, Advantages & Disadvantages (a,c) | | | | | | | | | | | |
| **Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
| | CO1 | M | | M | | | | | | | | | |
| | CO2 | M | | M | | | | | | | | | |
| | CO3 | M | | M | | M | | | | | | H | |
| | CO4 | M | | M | | | | | | | | | |
| **Course Content** | **UNIT I:**<br>**Numerical Control in Production Systems:** Introduction, Historical background, role of computers in manufacturing, components of NC Systems, Need for numerical control, Classification of NC systems, NC coordinate system, NC Applications, Advantages and disadvantages of NC machines, Recent trends in NC systems.<br><br>**UNIT II:**<br>**Computer Control of NC Machines:** Introduction, Principles of operation of CNC, Features of CNC, Developments in CNC systems, Direct Numerical Control (DNC), Types of DNC, Advantages of CNC and DNC, Adaptive Control Machining.<br>**Manual Part Programming:** Introduction, Manual Part Programming, Codes & Concepts, Cutter Length Compensation, Cutter Radius Compensation, Canned Cycles, Simple Programming Examples.<br><br>**UNIT III:**<br>**Computer Assisted Part Programming:**Advantages of Computer Assisted Part | | | | | | | | | | | | |

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| | Programming, APT Language, Geometry, Motion Commands, Macros, Simple Programming Examples.<br>**Group Technology:**Introduction, Part Families, Parts Classification and Coding, Different parts classification and coding systems, Cellular Manufacturing, Composite Part Concept, Benefits of Group Technology.<br><br>**UNIT – IV:**<br>**Computer Aided Process Planning:**Types of Computer Aided Process Planning, Retrieval type of Process Planning Systems, Generative Process Planning Systems, Benefits of CAPP.<br>**Flexible Manufacturing Systems:** Introduction, Types of Flexible Manufacturing Systems, FMS Layout configurations, Automated Guided Vehicle Systems and its working principles, control and safety aspects of A G V S, FMS Applications and Benefits, Introduction to Computer Integrated Manufacturing Systems (CIMS). |
| **Textbooks and Reference books** | **Text Books:**<br>1. P. N. Rao, T. K. Kundra& N. K. Tiwari, "Numerical Control & Computer Aided Manufacturing", Tata Mc- Graw Hill Publishers, New Delhi, 2008.<br>2. Mikell P. Groover, "Automation, Production Systems and CIM", Prentice Hall of India, 2nd Edition, New Delhi, 1995.<br><br>**Reference books:**<br>1. Mikell P. Groover, "CAD/ CAM", Prentice Hall of India, 3rd Edition, Delhi, 1995.<br>2. YoramKoren, " Computer Control of Manufacturing Systems", Mc- Graw Hill International Publishers, Singapore, 2010.<br>3. N. K. Mehta, "Machine Tool Design and Numerical Control", Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 2008. |
| | **Web Resources:**<br>1. http://nptel.iitm.ac.in<br>2. http://www.engr.sjsu.edu<br>3. http://web.iitd.ac.in<br>4. http://www.enotes.com/computer-aided-design-cad-cam<br>5. www.britannica.com/EBchecked/topic/130575/computer -aided-manufacturing<br>6. http://en.wikipedia.org/wiki/Computer-aided_design#overview<br><br>**Video Lessons:**<br>http://www.youtube.com/watch?v=83rhQ6oehIc<br>http://www.metacafe.com<br>http://www.youtube.com/watch?v=nvZBtJ-ncEM |

## 14ME3703 - REFRIGERATION & AIR CONDITIONING

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| **Course Category:** | Program Core | **Credits:** | 4 |
| **Course Type:** | Theory | **Lecture-Tutorial-Practice:** | 4 - 0 -0 |
| **Prerequisites:** | 14ME3303Basic Thermodynamics<br>14ME3404Applied Thermodynamics<br>14ME3601 Heat Transfer | **Continuous Evaluation:** | 30 |
| | | **Semester end Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to: | |
| | CO1 | Understand and analyze air refrigeration system and systems used in aircrafts. (a,c,e) |
| | CO2 | Analyze simple VCR cycle and factors affecting the performance of the cycle and understand the operation of various devices of VCR system. (a,c,e) |
| | CO3 | Select the most appropriate refrigerant for a given cooling application and understand the impact of refrigerants on the environment. (h,i,j) |
| | CO4 | Understand the vapor absorption and other non conventional refrigeration systems and their application as alternatives to VCR systems. (a,c,h) |
| | CO5 | Understand thermodynamics of air –vapor mixtures and analyze A/C process & systems and heat pump circuits to design real world heating & cooling needs. (a,c,e,h,j) |

**Contribution of Course Outcomes towards achievement of Program Outcomes (H-High, M-Medium, L-Low)**

| | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | | H | | H | | | | | | | |
| **CO2** | M | | H | | H | | | | | | | |
| **CO3** | | | | | | | | H | M | H | | |
| **CO4** | M | | M | | | | | M | | | | |
| **CO5** | H | | H | | H | | | M | | M | | |

**Course Content**

**UNIT – I**

**Introduction to refrigeration:**Applications, methods of refrigeration, unit of refrigeration, C.O.P,

**Refrigerants-**classification, nomenclature, desirable properties commonly used refrigerants and alternative refrigerants.

**Air Refrigeration:**Bell Coleman cycle, Open and Dense air systems, Actualrefrigeration cycle, advantages of air refrigeration, refrigerationneeds of aircrafts, types of aircraftrefrigerationsystems, problems.

**UNIT – II**

**Vapor compression refrigeration:** simple vapor compression refrigeration cycle, T-S, P-h diagrams, Effect of super heating, subcooling, evaporative and condenser pressures, pressure losses, problems.

**VCR System components:**Compressors- types, comparison, Condensers - classification, working, Evaporators – Flooded and dry expansion types, Expansion devices –AEV, TEV and capillary tube.

**UNIT – III**

**Vapor absorption system:** COP of absorption system, max COP, working of $NH_3$ - water system, $H_2O$ -Li Br system, three fluid absorption system, comparison

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| | between VCR and VAR systems.<br>**Steam jet refrigeration system:** Principle of working, application, merits and demerits.<br>**Non-conventional refrigeration methods:** Principle and operation of thermoelectric refrigeration, Vortex tube and adiabatic demagnetization.<br><br>**UNIT – IV**<br>**Air conditioning**: Psychrometry- Psychrometric properties and processes, Psychrometric chart,Summer, winter and year round A/C systems, human comfort and effective temperature.<br><br>**Cooling Loads**: Sensible and latent heat loads, RSHF, GSHF, ESHF & ADP, air conditioning load calculations, Types of heating, heat pump, different heat pump circuits, application. |
| **Text books and Reference books** | **Text books:**<br>1. A course in refrigeration and air conditioning - S. C. Arora, Domkundwar, 2014<br>2. Refrigeration and air conditioning - C. P. Arora. Tata Mc Graw-Hill, 7th Print, 2006<br><br>**Reference books:**<br>**1.**Principles of Refrigeration - Dossat., 4th Reprint 1997,Pearson Education Ltd.<br>2.Refrigeration and air conditioning - Stoecker and Jones 1983, McGraw Hill<br>**Data Books**:<br>1.Refrigeration and Air conditioning Data book by Domkundwar&Domkundwar , Dhanapat Rai & Co.<br>2.Refrigerant & Psychrometric Tables & charts., SS Banwait and SC Laroiya, Birla publication pvt ltd. |
| **E-resources** | **Web Resources**:<br>1. http://www.refrigerationbasics.com/index.htm<br>2. http://www.howstuffworks.com/ac.htm<br>3. http://www.ashrae.org<br>4. http://www.taftan.com/thermodynamics/AIRCOND.HTM<br>5. http://www.wisegeek.com/how-does-air-conditioning-work.htm |

**14ME4704/1 -MECHATRONICS**

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|---|---|---|---|
| **Course Category:** | ProgramElective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture-Tutorial-Practice:** | 3-1-0 |
| **Prerequisites:** | 14ME3306 Kinematics of Machines<br>14EC1305 Basics of Electronics Engineering | **Continuous Evaluation:** | 30 |
| | | **Semester end Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to: | |
| | CO1 | Understand the working principle of various Sensors and Transducers (a,d,k) |
| | CO2 | Develop system models & transfer function for Mechanical, Electrical, Fluid & Thermal systems (a,e,i) |
| | CO3 | Understand the working principle of different controllers such as Proportional, Derivative, Integral, PI, PD and PID. (a,d,k) |
| | CO4 | Understand the case studies of Mechatronics systems like pick-and-place robot, Timed switch and Barcode reader (a,d,i,k) |

| **Contribution of Course Outcomes towards achievement of Program Outcomes (H-High, M-Medium, L- Low)** | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | | | M | | | | | | | H | |
| **CO2** | M | | | | H | | | | H | | | |
| **CO3** | M | | | H | | | | | | | H | |
| **CO4** | M | | | H | | | | | H | | H | |

**Course Content**

**UNIT – I**

Introduction to Mechatronics

**Sensors & Transducers:** Introduction, performance terminology, Classification of sensors: Potentiometer sensor, strain gauged element, Capacity element, LVDT, Optical Encoders, Tachogenerator and stain gauge load cell, Selection of sensors.

**Signal Conditioning**: Introduction data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion.

Operation amplifier: inverting amplifier,summing amplifier, integrating amplifer,difference amplifier,flitering process

**UNIT – II**

**Basic System Models:** Modeling of one and two degrees of freedom Mechanical, Electrical, Fluid and thermal systems. Block diagram representations for these systems.

**System Transfer functions**: The Transfer function, Laplace transforms, First order systems, Second order systems, systems in series, systems with feedback loops.

**UNIT – III**

**Closed loop controllers:** Continuous and discrete processes, control modes, Two step, Proportional, Derivative, Integral, PID controllers.

**Digital logic:** Logic gates, application logic gates digital comparator, coder,SR flip-

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| | **UNIT – IV**<br>**PLC** : Introduction, basic structure, I/P, O/P, processing, programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output, selection of PLC.<br><br>**Design** : Designing Mechatronics systems, possible design solutions, case studies of Mechatronics systems – i) Pick and place robot ii) Timed switch iii) Bar code-reader |
| **Text books and Reference books** | **Text Books:**<br><br>Mechatronics by W.Bolton, Pearson Education India 3rd Edtion, 2006.<br><br>**References:**<br>1.Mechatronics by HMT,1st Edition,2010.<br>2.Mechatronics by Mahalik,1st Edition,2003 TMH.<br>3.Introduction to Mechatronics – David and Alcaitore Michael B.Histand TMH, 4th Edition, 2006. |
| **E-resources and other digital material** | 1. http://www.engr.sjsu.edu/sjlee/vendors.htm<br>2. www.engr.colostate.edu/~dga/mechatronics/resources.html<br>3. www.NI.com<br>4. www.cambridgemechatronics.com/contact/terms<br>5. www.pdf-free-download.com/mechatronics-labs.pdf<br>6. mechatronics.me.wisc.edu |

## 14ME4704/2 - COMPUTATIONAL FLUID DYNAMICS

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| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3- 1 - 0 |
| **Prerequisites** | 14MA1101 Linear Algebra and Differential Equations<br>14MA1301 Complex Analysis and Numerical Methods<br>14ME3303 Basic Thermodynamics<br>14ME 3403Fluid Mechanics<br>14ME3601 Heat Transfer | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the philosophy of CFD and derive governing equations of fluid flow. (a,c,e) |
| | CO 2 | Understand the principles of discretization. (a,c,e,k) |
| | CO 3 | Formulate solution techniques for parabolic and hyperbolic equations. (a,c,e,k) |
| | CO 4 | Apply some of the popular FD techniques in the solution of fluid flow problems (a,c,e,k) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | H | | L | | M | | | | | | | |
| | CO 2 | H | | L | | M | | | | | | M | |
| | CO 3 | M | | L | | H | | | | | | M | |
| | CO 4 | M | | L | | H | | | | | | M | |

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| **Course Content** | **Unit I:**<br>Importance and applications of CFD, Models of flow, governing equations of fluid flow – Navier Stokes and Euler's equations: Continuity, Momentum and Energy equations in differential form, Physical boundary conditions. |
| | **Unit II:**<br>Classification of partial differential equations, Discretization techniques- FDM, FEM, FVM, Finite Difference equations- Taylor series, order of accuracy, forward, backward and central differences for first order and second order differential equations. |
| | **UnitIII**:<br>Difference equations, Explicit and Implicit approaches, Thomas Algorithm (TDMA). Analysis of stability, VN stability criteria for parabolic (1-D unsteady heat equation) and Hyperbolic (1$^{st}$ order wave equation) equations, Courant number. |

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| | **UnitIV**:<br>Simple CFD techniques: Lax-Wendroff technique, MacCormack's technique and Iterative and Relaxation techniques. Pressure correction technique, staggered grid, SIMPLE algorithm, Boundary conditions for pressure correction method. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Computational Fluid Dynamics - Basics with Applications - John. D. Anderson, JR. McGraw Hill Education (India) Edition 2012.<br>2. Computational Fluid Dynamics - T. J. Chung, Cambridge University Press, 2nd Edition, 2014.<br>**Reference Books:**<br>1. Introduction to computational fluid mechanics - Niyogi, Chakravarty, Laha, Pearson pub. 1st Edition, 2009.<br>2. Numerical heat transfer and fluid flow - S.V. Patankar, Hemisphere Pub., 1st Edition.<br>3. Computational Fluid flow and Heat transfer - K. Muralidhar and T. Sundararajan-, Narosa Pub. 2nd Edition, 2003. |
| **E- resources and other digital material** | **Web Resources:**<br>http://ocw.mit.edu/courses/mecharlical-engineering/2-29-numerigal-fluidmechanics-fall2011/<br>http:/inptel.ac.in/courses/112105045/ (IIT Kharagpur)<br>http://nptel.ac.in/courses/112107080/ (IIT Roorkee)<br>http://nptel.ac.in/courses/112104030/ (IIT Kanpur)<br>littp://www.nptelvideos.in/2012/11/computational-fluid-d)'namics.html(IIT Madras)<br>http://www.cfd-onIine.com/ |

## 14ME4704/3 -HYDRAULIC AND PNEUMATIC SYSTEMS

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| **Course Category:** | ProgramElective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practice:** | 3 - 1 – 0 |
| **Prerequisites:** | 14ME3403Fluid Mechanics | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

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| **Course outcomes** | | Upon successful completion of the course, the student will be able to: |
| | **CO1** | Understand the working Principles of Hydraulic pump and actuators (a,c,d) |
| | **CO2** | Understand the working of different Control valves and Hydraulic Circuits (a,c,d,k) |
| | **CO3** | Understand basic Principles and Control of Pneumatic Systems (a,c,d,k) |
| | **CO4** | Identify faults in the hydraulic systems and maintenance of the hydraulic system. (a,c,d,k) |

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| **Contribution of Course Outcomes towards achievement of Program Outcomes (L – Low, M- Medium, H – High)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
| | **CO1** | M | | M | M | | | | | | | | |
| | **CO2** | M | | M | M | | | | | | | M | |
| | **CO3** | M | | M | M | | | | | | | M | |
| | **CO4** | M | | M | M | | | | | | | M | |

**Course Content**

**UNIT I:**
**Introduction:** Fluid Power, Basic Law, Application of Fluid Power, Advantages of Fluid Power Systems, Types of Fluid Power Systems.
**Hydraulic Systems:** Pumps – Gear Pumps, Vane Pumps Piston Pumps. Selection and Specification of Pumps.
**Hydraulic Actuators**: Linear and Rotary Actuators

**UNIT II:**
**Control and Regulation Elements:** Pressure, Flow and Direction Control Valves
**Hydraulic Circuits**: Reciprocation, Quick Return, Sequencing, Synchronizing Circuits, Industrial Circuits - Punching Press Circuit, Milling Machine Circuits

**UNIT III:**
**Introduction to Pneumatic Systems**: Pneumatic fundamentals, Pneumatic Valves
**Pneumatic Circuits**: Pneumatic circuits- Basic pneumatic circuit, Quick exhaust circuit, feed control circuit and Time delay circuit

**UNIT – IV**
**Hydraulic Circuits**: Accumulators, Accumulator Circuits – Leakage Compensation, Auxiliary Power Source, Emergency Source of Power
**Maintenance of Hydraulic Systems**: Maintenance of Hydraulic Systems, Trouble Shooting of Hydraulic System.

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| **Text books and Reference books** | **Text Book:**<br>1. Antony Espossito, "Fluid power with Applications", Prentice Hall, 1980<br>2. R Srinivasulu, “Hydraulic Pneumatic Controls”, 2nd edition, TMH, 2009.<br><br>**Reference books:**<br>1. Andrew Parr, "Hydraulics and Pneumatics", (HB), Jaico Publishing House, 1999<br>2. Bolton. W. "Pneumatic and Hydraulic systems", Butterworth - Heinneman, 1997 |
| **E-resources and other digital material** | 1. http://www.efluids.com/<br>2. http://fluid.power.net/<br>3. www.hydraulicspneumatics.com/<br>4. www.waterengr.com/<br>5. www.pumps.org/ |

## 14ME4704/4 - RELIABILITY ENGINEERING

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|---|---|---|---|
| **Course Category** | ProgramElective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3-1 - 0 |
| **Prerequisites** | 14MA1101 Linear Algebra and Differential Equations<br>14MA1301 Complex Analysis and Numerical Methods | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand various concepts of mortality curve. (a,b,i) |
| | CO 2 | Understand different types of failure distributions. (a,b,i) |
| | CO 3 | Understand reliability prediction models. (a,b,i) |
| | CO 4 | Understand the concepts of reliability management. (a,b,i) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M- Medium , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO1 | M | M | | | | | | | M | | | |
| | CO2 | M | M | | | | | | | M | | | |
| | CO3 | M | M | | | | | | | M | | | |
| | CO4 | M | M | | | | | | | M | | | |

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| **Course Content** | **Unit I:**<br>**Reliability Concept:** Reliability function - failure rate - Mean time between failures (MTBF) -Mean time to failure (MTTF) – a priori and a posteriori concept - mortality curve - useful life Availability - maintainability – system effectiveness. |
| | **Unit II:**<br>**Reliability Data Analysis:** Time to failure distributions - Exponential, normal, Gamma, Weibull,Ranking of data - probability plotting techniques. |
| | **UnitIII**:<br>**Reliability Prediction Models:** Series and parallel systems - RBD approach - Standby systems -M/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis -FTA – Limitations |
| | **UnitIV**:<br>**Reliability Management:** Reliability testing - Reliability growth monitoring - Non parametric Methods - Reliability and life cycle costs –Reliability allocation - Replacement model. |

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| | **Concept of risk**- objective and scope of risk assessment- probabilistic Risk- risk perception and acceptability- PRA management- preliminary hazard analysis- HAZOP and HAZAN, FMEA and FMECA analysis, Fault tree Analysis Reliability-based optimum design, Strength-based reliability |
| **Text Books and Reference Books** | **Text Books**:<br>1. Singiresu S. Rao 'Reliability Engineering' 1st Edition Pearson, 2014<br>2.Modarres, "Reliability and Risk analysis ", Mara Dekker Inc., 1993.<br>**Reference books:**<br>1. John Davidson, "The Reliability of Mechanical system ", published by the Institution of Mechanical Engineers, London, 1988.<br>2. Smith C.O." Introduction to Reliability in Design ", McGraw Hill, London, 1976. |
| **E- resources and other digital material** | **Web resources:**<br>1. http://Life Data Analysis<br>2. http://nptel.ac.in/courses/10567/reliability<br>3. www.Reliability Growth Analysis.com<br>4. www.FMEA and FMECA Analysis.com |

## 14ME4704/5 - OPTIMIZATION TECHNIQUES

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|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3-1 - 0 |
| **Prerequisites** | 14MA1301 Complex Analysis and Numerical Methods | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course,the student will be able to | |
| | CO 1 | Solve Integer programming and Geometric Programming problems. (a,c,e) |
| | CO 2 | Solve Non linear programming problems and linear models by dynamic programming. (a,c,e) |
| | CO 3 | Familiarize with the basic concepts of replacement analysis and Resource allocation. (a,c,e,l) |
| | CO 4 | Solve different Optimization problems (a,c,e) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M-Medium , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO1 | M | | M | | M | | | | | | | |
| | CO2 | M | | M | | M | | | | | | | |
| | CO3 | M | | M | | M | | | | | | | H |
| | CO4 | M | | M | | M | | | | | | | |

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| **Course Content** | **Unit I:**<br>**Integer Programming:** Cutting – Plane Algorithms, Branch and Bound method.<br>**Geometric Programming:** Introduction, Polynomial, Unconstrained Geometric Programming, Constrained Geometric Programming, Complementary Geometric Programming. |
| | **Unit II:**<br>**Non Linear Programming:** Unconstrained nonlinear optimization, constrained nonlinear optimization, Kuhn tucker Conditions.<br>**Dynamic Programming:** Elements of Dynamic Programming model, Problem of dimensionality in Dynamic Programming, Solution of linear programs by Dynamic Programming. |
| | **UnitIII**:<br>**Replacement Analysis:** Replacement of items that deteriorate with time – value of money changing with time –not charging with time – optimum replacement policy – individual and group replacement.<br>**Project Management:** Resource Allocation, Resource leveling. |
| | **UnitIV**:<br>Applications of Optimization in Design And Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, Design of two |

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| | bar truss, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, Optimization Hydraulic Cylinder. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Operations Research: Principles And Practice, 2nd Ed Ravindran, Phillips, Solberg John Wiley & Sons 2007.<br>2. 'Operations Research (units: I, IV)'SD Sharma,'Kedarnath, Ramnath& Co.,Meerut.16th edition 2009.<br>3. 'Engineering Optimization Theory and Practice' (III edition) SS Rao New Age International-2014<br>**Reference Books:**<br>1. Operations Research' R Pannerselvam 2ne Edition 2006, Pentice Hall Of India Pvtltdnew Delhi. |
| **E- resources and other digital material** | **Web resources:**<br>• http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.htm<br>• http://www.wolfram.com/solutions/OperationsResearch/<br>• http://www.informs.org/Journal/IJOC/Areas-and-Area-Editors<br>• http://orion.uwaterloo.ca/~hwolkowi/intrstsites.html |

**14ME 4705/1 - COMPUTER AIDED DESIGN**

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|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3-1 - 0 |
| **Prerequisites** | 14MA1101 Linear Algebra and Differential Equations | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the Importance of application of Computer for design, Design work station, Display file structure and Normalized device coordinates. (a,d,k) |
| | CO 2 | Understand algorithms for different graphic primitives such as Line and Circle (a,d,k) |
| | CO 3 | Understand 2D and 3D wire frame models and Parametric and Non Parametric representation of curve. (a,d,k) |
| | CO 4 | Understand Surface Modeling, representation of surface patch, Solid modeling like CSG and B-Rep. (a,d,k) |
| | CO 5 | Understand and apply the concepts of Graphic Transformations and windowing (a,d,k) |

| **Contribution of Course Outcomes towards achievement of Program Outcomes (H- High, M-Medium, L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO1 | M | | | M | | | | | | | M | |
| | CO2 | M | | | M | | | | | | | M | |
| | CO3 | M | | | M | | | | | | | M | |
| | CO4 | M | | | M | | | | | | | M | |
| | CO5 | M | | | M | | | | | | | M | |

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| **Course Content** | **Unit I:**<br>**Introduction:** Fundamentals of CAD, Design process, Applications of computer for design, Benefits of CAD, Design Workstation, Graphic terminal.<br>**Graphic Primitives:**The Display-File Interpreter, Normalized Device Coordinates, Display-File structure. |
| | **Unit II:**<br>**Primitives**: Point Plotting, Drawing of Lines, Line drawing algorithms - DDA Algorithm, Bresenham's Line Drawing Algorithm, Mid Point Circle algorithm.<br>**Geometric Modeling**: 2D wire frame modeling, 3D Wire frame modeling, Wire frame models, Entities and their definitions. Concept of Parametric and nonparametric representation of curve. |
| | **Unit III:**<br>**Surface Modeling:** Surface modeling and entities, Algebraic and geometric form, Parametric space of Surface, Blending functions, Reparametrisation of |

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| | surface patch, Sub dividing cylindrical surface, Ruled surface, Surface of revolution, Spherical surface, Composite surface.<br>**Solid Modeling:** Solid models, Solid entities, Solid representation, Sweep representation, Constructive Solid Geometry (CSG) and Boundary representation (B-rep). |
| | **Unit IV:**<br>**GeometricTransformations**: Co-ordinate System used in Graphics. 2-D Transformations - Scaling, Translation, Rotation. Homogeneous Transformations, Combination Transformations, 3-D Transformations.<br>**Windowing**: Windowing, Viewport and Viewing Transformation. |
| **Text Books and Reference Books** | **Text Books**:<br>1. CAD/CAM by Mikel P. Groover and Emory W.Zimmers, Prentice Hall of India , Delhi,3rd Edition-2007.<br>2. Computer Aided Design and Manufacture by C.B.Besant, and C.W.K.Lui, Affiliated East – West Press Pvt Ltd, New Delhi. 3rd Edition-2007.<br>**Reference Books:**<br>1. CAD/CAM by Ibrahim Zied, 5th Re print-2002. TMH |
| **E- resources and other digital material** | **Web resources:**<br>1. http://en.wikipedia.org<br>2. http://www.learnerstv.com<br>3. http://www.caddprimer.com/<br>4. http://www.compinfo-center.com/cad/cad.htm<br>5. http://www.srikumar.com/cad/cad.html<br>6. http://www.tenlinks.com/CAD/reference/directories.htm<br>**Video Reference:**<br>1. http://blog.capinc.com/2010/06/convert-to-a-section-view/<br>2. http://www.solidsmack.com/design-resources/solidworks-lamborghini-gallardo-car-tutorial/ |

## 14ME 4705/2DESIGN FOR MANUFACTURING AND ASSEMBLY

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|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3 - 1 - 0 |
| **Prerequisites** | 14ME3302 Mechanics of Materials<br>14ME4302 Advanced Mechanics of Materials | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the concepts of design and materials of design for manufacturing. (a,c) |
| | CO 2 | Acquaint with the knowledge of designing creative components considering ethical , human factors (a,f,h,i,j) |
| | CO 3 | Identify the design factors for casting welding and forging. (a,c) |
| | CO 4 | Understand the principles of machinating and assembly processes and eco-efficient considerations in design. (a,c,h) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | M | | | | | | | | | |
| | CO 2 | M | | | | | H | | H | M | M | | |
| | CO 3 | M | | H | | | | | | | | | |
| | CO 4 | M | | H | | | | | H | | | | |

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| **Course Content** | **Unit I:**<br>**Introduction:** Design Philosophy, Steps in Design process, general Design rules for manufacturability, basic principles of designing for economical production, creativity in design.<br>**Materials:** Selection of materials for design, developments in material technology, criteria for material selection , material selection interrelation ship with process selection. |
| | **Unit – II**<br>**Design in a Broader Context**<br>Spectrum of Engineering activities – Organization of Engineering function – Engineering profession - Ethics in engineering – societal considerations –Product life Cycle – Technology forecasting – Technology innovation – Human factors in Design – Design for occupational safety and health – Industrial Design |
| | **Unit – III**<br>**Metal Casting:** Appraisal of various casting processes, selection of casting process, general design considerations for casting, casting tolerances, use of solidification simulation in casting design Product Design rules for sand casting<br>**Metal Joining:** Appraisal of various welding processes, factors in Design of weldments, general design guidelines – pre and post treatment of welds – effects of thermal stresses |

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| | in weld joints – design of brazed joints.<br>**Forging:** Design factors for forging, closed die forging design, parting lines of dies, drop forging die design, general design recommendations |
| | **Unit – IV**<br>**Machining Processes**: Overview of various machining processes, general design rules for machining Dimensional tolerance and surface roughness Design for machining, general design recommendations for machined parts<br>**Assembly:** Approaches to design for assembly - Approaches based on design principles and rules Qualitative evaluation procedures, knowledge based approach<br>**Environment:** Introduction , motivations for environment, principles of environment eco-efficiency , product life cycle perspective, environment tools and processes, environment design guidelines |
| **Text Books and Reference Books** | **Text Books**:<br>1. Harry Peck., Design for Manufacture, Pittman Publication, 1983<br>2. George E. Dieter, Engineering Design – A materials and Processing Approach' 2nd edition, Mc Graw Hill, International Editions, Singapore, 1991.<br>3. Alan Redford and Chal, Design for Assembly - Principles and Procedures, McGraw Hill International Europe, London, 1994<br><br>**Reference Books:**<br>1. Robert Matousek., Engineering Design - A Systematic Approach, Blackie & Sons Ltd, 1963<br>2. James G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Co., 1986<br>3. Swift, K. G., Knowledge Based Design for Manufacture, Kogan Page Ltd., 1987 |
| **E-resources and other digital material** | 1. http://www.npd-solutions.com<br>2. http://poeth.com<br>3. http://hubpages.com<br>4. www.sciencedirect.com<br>5. http://soa.asee.org |

## 14ME4705/3 - MECHANICAL VIBRATIONS

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|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3-1 - 0 |
| **Prerequisites** | 14 ME 1107,14ME1205 Mechanics for Engineers<br>14ME3503 Machine Dynamics | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the concepts of damping. (a,b,c,e) |
| | CO 2 | Solve one d.o.f. forced vibration problems. (a,b,c,e) |
| | CO 3 | Solve two-degrees of freedom systems for natural frequencies. (a,b,c,e) |
| | CO 4 | Solvemulti-degrees of freedom systems for natural frequencies. (a,b,c,e) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M- Medium L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | M | L | | H | | | | | | | |
| | CO 2 | M | M | L | | H | | | | | | | |
| | CO 3 | M | M | L | | H | | | | | | | |
| | CO 4 | M | M | L | | H | | | | | | | |

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| **Course Content** | **Unit I:**<br>**Free vibrations of undamped and damped single DOF systems:**Overview ofundamped single DOF systems, Different types of damping, Free vibrations with viscous damping, Over-damped system, Critically-damped system, Under-damped system, Logarithmic decrement, Viscous dampers, numerical problems on damped free vibrations.<br>**Forced vibrations of single DOF systems:** Introduction, Forced vibrations with constant harmonic excitation, steady state vibrations, numerical problems. |
| | **Unit II:**<br>**Applications of Forced vibrations of single DOF systems:** Forced vibrations with rotating and reciprocating unbalance, Forced vibrations due to excitation of the support, Energy dissipated by damping, Vibration isolation and transmissibility, numerical problems.<br>**Critical speeds of shafts:** Critical speed of a light shaft having a single disc without damping, critical speed of a light shaft having a single disc-with damping, numerical problems. |
| | **Unit III:**<br>**Two-degrees of freedom systems**: Principal modes of vibration, natural frequencies of systems with rectangular modes, Natural frequencies of a double pendulum, natural frequencies of torsional systems, Semi-definite system, numerical problems. |

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| | Combined rectilinear and angular modes, numerical problems, Undamped forced vibrations with harmonic excitation.<br>Vibration absorbers: undamped dynamic vibration absorber, Torsional absorber system, centrifugal pendulum absorber. |
| | **Unit IV:**<br>**Multi-Degree of freedom systems – exact analysis:** Free vibrations- equations of motion, Influence coefficients, generalized coordinates and coordinate coupling, Natural frequencies and mode shapes (Eigen values and Eigenvectors), numerical problems.<br>Orthogonal properties of the normal modes, modal analysis: undamped free vibrations.Continuous Systems: Longitudinal vibrations of bars, numerical problems. |
| **Text Books and Reference Books** | **Text Books**:<br>Mechanical Vibrations by G. K. Grover, New Chand & Bros, 8th edition, 2009.<br>**Reference Books:**<br>1. Mechanical Vibrations by R. Venkatachalam, PHI Learning Private Limited, 2014.<br>2. Mechanical Vibrations: V.P.singh, Dhanpat Rai & Co. (P) Ltd, Delhi, 4th edition, 2015 |
| **E-resources and other digital material** | **Web Resources:**<br>http://ocw.mit.edu/courses/mechanical-engineering/2-003scengineeringdynamics -fall-2011/mechanical-vibration/<br>http://nptel.ac.in/courses/112103112/1<br>http://freevideolectures.com/Course/2684/Mechanical-Vibrations |

## 14ME4705/4 – SIGNAL ANALYSIS AND CONDITION MONITORING

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| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3 -1 - 0 |
| **Prerequisites** | 14MA1101 Linear Algebra and Differential Equations | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the basic concepts of Signal Analysis and Identify the appropriate technique for analyzing stationary signals. (a,b,e) |
| | CO 2 | Identify the appropriate measures to analyze Non stationary signals. (b,e) |
| | CO 3 | Analyze the periodic signals with valid constraints. (b,e) |
| | CO 4 | Understand the condition monitoring procedures for real dynamic systems. (a,c,d,j,k) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun, L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | H | M | | | M | | | | | | | |
| | CO 2 | | M | | | M | | | | | | | |
| | CO 3 | | M | | | M | | | | | | | |
| | CO 4 | M | | M | M | | | | | | M | M | |

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| **Course Content** | **Unit I:**<br>**Introduction:** Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.<br>**Signal analysis:** Filter response time. Detectors. Recorders. Analog analyzer types.<br>**Practical analysis of stationary signals**: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis. |
| | **Unit II:**<br>**Practical analysis of continuous non-stationary signals**: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results. |
| | **Unit III:**<br>**Practical analysis of transients**: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth). |
| | **Unit IV:**<br>**Condition monitoring in real systems**:<br>Field Balancing of Rotors, Condition Monitoring of Rotating Machines, Noise Monitoring, Wear & Debris Analysis, Thermography, Electric Motor Current Signature Analysis, Ultrasonics in Condition Monitoring, NDT Techniques in Condition Monitoring, |

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| | **Case studies:** Condition monitoring of two stage compressor, cooling tower fan. Air separator |
| **Text Books and Reference Books** | **Text Books**:<br>1. Signals and Systems, PHI; 2 editionB P Lathi, 2014<br>2. Mechanical Vibrations Fifth Edition S S Rao Prentice Hall 2011<br><br>**Reference Books:**<br>1. Frequency Analysis /R.B.Randall.<br>2. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.<br>3. Condition Monitoring of Mechanical Systems / Kolacat. |
| **E-resources and other digital material** | **Web Resources:**<br>1.https://aerocastle.files.wordpress.com/2012/10/mechanical_vibrations_5th-edition_s-s-rao.pdf.<br>2.https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/ |

## 14ME4705/5 PRODUCT DESIGN AND DEVELOPMENT

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|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3-1 - 0 |
| **Prerequisites** | Nil | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the technical and business aspects of the product development process (a,c,i,k) |
| | CO 2 | Establish technical specifications according to customer needs (a,b,c,d,i,j,k) |
| | CO 3 | Appreciate product architecture, planning, design and manufacturing issues (a,c,i,k) |
| | CO 4 | Understand the intellectual property rights, and the principles of project economics and management (a,c,f,i,k,l) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | L | | H | | | | | | M | | M | |
| | CO 2 | L | H | H | M | | | | | M | H | M | |
| | CO 3 | L | | H | | | | | | M | | M | |
| | CO 4 | L | | H | | | H | | | M | | M | M |

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| **Course Content** | **Unit I:**<br>**Introduction**<br>Product development – Characteristics, Duration and cost, Challenges, Organizational realities. Development process – processes, process flows, development organizations. Product planning process – identifying opportunities, prioritization, resource allocation and plan timing, pre-project planning and reflection on results. Customer Needs – data gathering, interpretation of raw data, organizing, establishing the relative importance, reflection on results. |
| | **Unit II:**<br>**Concept Development**<br>Product specifications, establishing target specifications, setting final specifications, various steps in concept generation, selection of Concepts, overview of methodology - concept screening and scoring, CAVEATS. Concept Testing – survey, communicate, response and interpretation. |
| | **Unit III:**<br>**Design Process**<br>Product Architecture – implementation, establishing, delayed differentiation, Platform planning, system level design issues. Industrial design – needs, impact, processes, management and assessing the quality. Design for manufacture – overview of DFM |

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| | process. Prototyping – principles, technologies, planning. |
| | **Unit IV:**<br><br>**Intellectual Property Rights and Project Economics**<br>Robust design – process. Intellectual Property Rights, overview of patents, utility patents, preparing a disclosure. Product development economics – elements of economic analysis. Managing projects – understanding and representing tasks, baseline project planning, accelerating projects, project execution and postmortem project evaluation. |
| **Text Books and Reference Books** | **Text Books**:<br><br>1. Karl T Ulrich, Steven D Eppinger and Anita Goyal "Product Design & Development" McGraw Hill 4th Edition, 2008<br><br>**Reference Books:**<br><br>1. G. E. Dieter, "Engineering Design", McGraw – Hill International, 2009.<br>2. Ken Hurst, "Engineering Design Principles", Elsevier Science and Technology Books, 2006.<br>3. Suh, N.P., "The principles of Design", Oxford University Press, NY.1990.<br>4. Ray, M.S., "Elements of Engg. Design", Prentice Hall Inc. 1985.<br>5. E. Deborah and Bouchoux, "Intellectual Property Rights", Cengage Learning India Pvt., 2008.<br><br>**WEB REFERENCES**<br><br>1.https://youtu.be/5OQAD606Yow<br>2.https://youtu.be/oLmSw236UFA |

# 14ME3751 – HEAT TRANSFER LAB

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| **Course Category** | Program Core | **Credits:** | 2 |
| **Course Type** | Laboratory | **Lecture – Tutorial – Practice** | 0- 0 - 3 |
| **Prerequisites** | 14ME3303 Basic Thermodynamics<br>14ME3404Applied Thermodynamics<br>14ME3601 Heat Transfer | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Determine thermal conductivity of materials and analyzed in composite walls (a,b,c,k) |
| | CO 2 | Evaluate convective heat transfer coefficient for internal and external flows (a,b,c,k) |
| | CO 3 | Measure Stefan boltzman constant and Emissivity of a grey body (a,b,c,k) |
| | CO 4 | Determine overall heat transfer coefficient of heat exchangers (a,b,c,k) |
| | CO 5 | Determine COP measurement of Vapour compression Refrigeration cycleand air-conditioning (a,b,c,k) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | H | M | | | | | | | | L | |
| | CO 2 | M | H | M | | | | | | | | L | |
| | CO 3 | M | H | M | | | | | | | | L | |
| | CO 4 | M | H | M | | | | | | | | L | |
| | CO 5 | M | H | M | | | | | | | | L | |

| | |
|---|---|
| **Course Content** | **<u>Any Eight Experiments of the following</u>**<br>1. Measurement of Thermal conductivity of metal rod<br>2. Measurement of Thermal conductivity of insulating powder<br>3. Heat transfer through a lagged pipe apparatus<br>4. Heat transfer from pin fin in natural convection<br>5. Heat transfer from pin fin in forced convection<br>6. Determine Forced convection heat transfer coefficient through a duct<br>7. Determine the value of Stefan boltzman constant<br>8. Measurement of Emissivity a grey body<br>9. Determine overall heat transfer coefficient in Parallel flow heat exchanger & Counter flow heat exchanger<br>10. Determine COP of Vapour compression Refrigeration cycle<br>11. Performance evaluation of Air-conditioning<br>12. User defined design based experiment. |

## 14ME 3752 DESIGN & METROLOGY LABORATORY

| | | | |
|---|---|---|---|
| **Course Category:** | Programme Core | **Credits:** | 2 |
| **Course Type:** | Laboratory | **Lecture - Tutorial - Practice:** | 0 - 0 -3 |
| **Prerequisites:** | 14ME3503Machine Dynamics<br>14ME4705/2Mechanical Vibrations<br>14ME4705/3 Experimental Stress Analysis | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

| **Course outcomes** | | Upon successful completion of the course, the student will be able to: |
|---|---|---|
| **Design laboratory** | **CO1** | Evaluate the time period of oscillations of simple, compound pendulums, bifilar, for springs in series, for springs in parallel, torsional vibration, and forced un-damped longitudinal vibration. (a,b,c,e,k) |
| | **CO2** | Determine the whirling speed of shafts under different boundary conditions. (a,b,c,e,k) |
| | **CO3** | Understand the gyroscopic effect of moving bodies. (a,b,c,e,k) |
| | **CO4** | Determine stresses in the material by using photo elastic bench. (a,b,c,e,k) |
| **Metrology laboratory** | **CO5** | Measure the taper angle of bore gauge, gear tooth thickness and elements of thread (a,b,e,k) |
| | **CO6** | Measure Surface Roughness, tool signature and cutting forces. (a,b,e,k) |
| | **CO7** | Conduct Alignment tests on machine tool. (a,b,e,k) |
| | **CO8** | Demonstrate the working of interferometer. (a,b,k) |
| | **CO9** | Demonstrate FFT analyzer, pneumatic comparator and Gauges. (a,b,e,k) |

| **Contribution of Course Outcomes towards achievement of Program Outcomes**<br><br>**(L – Low, M- Medium, H – High)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CO1** | M | M | M | | M | | | | | | M | |
| | **CO2** | M | M | M | | M | | | | | | H | |
| | **CO3** | M | H | M | | H | | | | | | H | |
| | **CO4** | H | H | H | | M | | | | | | H | |
| | **CO5** | M | H | | | M | | | | | | M | |
| | **CO6** | M | H | | | M | | | | | | M | |
| | **CO7** | M | H | | | M | | | | | | M | |
| | **CO8** | M | H | | | | | | | | | M | |
| | **CO9** | M | H | | | M | | | | | | H | |

| | |
|---|---|
| **Course Content** | **Design Laboratory:**<br>1. Vibration measurements:<br>(a) Simple, compound pendulums, bifilar.<br>(b) Springs in series, springs in parallel.<br>(c) Single and double rotor shaft system.<br>(d) Forced un-damped longitudinal vibration.<br>2. Determine the whirling speed of shafts.<br>3. Understand the gyroscopic effect of moving bodies using motorized Gyroscope.<br>4. Measurements using photo elastic bench:<br>(a) Study of diffused light plane polariscope.<br>(b) Study of diffused light circular polariscope.<br>(c) Principal stress difference determination.<br>5. User defined design based experiment.<br>**Note:** Any 6 experiments must be completed from Design Laboratory.<br><br>**Metrology Laboratory:**<br>**Experimentation:**<br>1. Measuring taper angle of bore gauge.<br>2. Measuring gear tooth thickness using gear tooth vernier<br>3. Measuring different elements of a thread using profile projector.<br>4. Measuring angular dimensions of a tool using tool -makers microscope.<br>5. Measurements of surface finish using surf tester<br>6. Measuring effective diameter of the thread using three wire method<br>7. Measurement of cutting forces using dynamometer on a lathe machine<br>8. Alignment test on a lathe machine<br>9. Alignment test on a Milling machine<br>10. Fringes observation using Interferometer.<br><br>**Model Demonstrations:**<br><br>1. Vibration measurements by using FFT Analyzer.<br>2. Use of pneumatic comparator<br>3. Demonstration of various gauges<br>**Note:** Any 6 experiments must be completed from Metrology Laboratory. |
| **Text books and Reference books** | 1. "Engineering Metrology and Measurements ", N. V. Raghavendra and L. Krishnamurthy – 2013,Oxford Press.<br>2. "Engineering Metrology" ,R.K.Jain , Khanna Publications – 2009. |
| **E-resources and other digital material** | 1. www.iitg.ernet.in/scifac/qip/public.../r.../chapter_5_gyroscope.pdf<br>2. www.nptel.ac.in/courses/112101096/download/lecture-25.pdf<br>3. https://en.wikipedia.org/wiki/Critical_speed<br>4. www.ifsc.usp.br/~lavfis/images/BDApostilas/.../photoelasticity.pdf<br>5. depts.washington.edu/mictech/optics/me557/photoelasticity.pdf<br>6. courses.washington.edu/me354a/photoelas.pdf |

## 14ME6753 INTERNSHIP

| | | | |
|---|---|---|---|
| **Course Category:** | Industry Interaction | **Credits:** | 2 |
| **Course Type:** | Laboratory | **Lecture - Tutorial - Practice:** | 0 - 0 - 4 |
| **Prerequisites:** | -- | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 0<br>100<br>100 |

**Course Oucomes:** At the end of the course the students will be able to

CO1 : Understand the current needs of the industry. (h, j)

CO2 : Understand techniques,processes and tools used in the industry. (b,c,e)

CO3 : Prepare technical report. (g)

CO4 : Realize the importance of self learning. (i)

## 14ME6754 INDUSTRY OFFERED COURSE

| | | | |
|---|---|---|---|
| **Course Category:** | Industry Interaction | **Credits:** | 2 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practice:** | 2 - 0-0 |
| **Prerequisites:** | -- | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 0<br>100<br>100 |

| | | |
|---|---|---|
| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the basic terminology and mechanical behaviour of FRP Composites (a,i) |
| | CO 2 | Realize the potential advantages and applications of FRP Composites (a,i) |
| | CO 3 | Understand the manufacturing methods of FRP Composites (a,c,i,k) |
| | CO 4 | Understand the curing and joining methods of FRP Composites (a,c,i,k) |

| **Contribution of COs towards achievement of POs** | | POa | POb | POc | POd | POe | POf | POg | POh | POi | POj | Pok | POl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | H | | | | | | | | M | | | |
| | CO 2 | H | | | | | | | | M | | | |
| | CO 3 | M | | H | | | | | | M | | H | |
| | CO 4 | M | | H | | | | | | M | | H | |

| | |
|---|---|
| **Course Content** | **Unit I:**<br>**Introduction to Composite Materials:**<br>Introduction, Classification and Characteristics of Composite Materials, Mechanical Behaviour |
| | **Unit II:**<br>**Advantages and Applications of Composite Materials:**<br>Current and potential advantages of Fiber-Reinforced Composite Materials, Applications of Composite materials. |
| | **Unit III:**<br>**Manufacturing Methods of Composite Materials:**<br>Filament winding, Compression molding, Resin transfer molding, Pultrusion |
| | **Unit IV:**<br>**Curing and Joining Methods of Composite Materials:**<br>Autoclave curing, Joining of Composite Materials: Bonded Joints, Bolted Joints, Bonded-Bolted Joints |
| **Text Books and Reference Books** | **Text Books**:<br>1. Mechanics of Composite Materials by R. M. Jones, 2nd edition, Taylor & Francis, 1999.<br>**Reference Books:**<br>1. Engineering Mechanics of Composite Materials by I. M. Daniel and O. Ishai, Oxford University Press, 2006.<br>2. Stress Analysis of Fiber-Reinforced Composite Materials by M. W. Hyer, |

| | |
|---|---|
| | McGraw-Hill International |
| **E-resources and other digital material** | 1.http://www.efunda.com/formulae/solid_mechanics/composites/comp_intro.cfm<br>2.http://www.compositesworld.com/blog/post/fabrication-methods<br>3.http://www.efunda.com/formulae/solid_mechanics/composites/comp_FRC_intro.cfm<br>4.http://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwig1rew9_3PAhVEwI8KHbRdB0AQFggpMAE&url=http%3A%2F%2Fnptel.ac.in%2Fcourses%2F112107085%2Fmodule7%2Flecture3%2Flecture3.pdf&usg=AFQjCNH9J7dTaiWVOd8pE7CsU_rsoTnHIw |

## 14ME5755 - MINI PROJECT

| | | | |
|---|---|---|---|
| **Course Category:** | Independent Learning | **Credits:** | 2 |
| **Course Type:** | Practical | **Lecture - Tutorial - Practice:** | 0 - 2- 0 |
| **Prerequisites:** | | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

**Course Oucomes:** At the end of the course the students will be able to

CO1:Identify,formulate and solve theoretical or practical engineering problems of simple nature. (a,e,f,g,h,i,j)

## 14ME3801 – MANUFACTURING MANAGEMENT

| | | | |
|---|---|---|---|
| **Course Category** | Program Core | **Credits:** | 4 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 4 - 0 - 0 |
| **Prerequisites** | Nil | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

| | | |
|---|---|---|
| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Familiarize with different types production systems, functions of PPC and various forecasting methods. (a,e,l) |
| | CO 2 | Plan the required Capacity using different strategies and develop a Master production schedule. (a,e,l) |
| | CO 3 | Manage the inventory in an efficient manner and develop a MRP schedule. (a,e,l) |
| | CO 4 | Identify the variations, causes taking place in a production process and familiarize with various inspection methods, quality philosophy's & e-manufacturing concept. (a,c,e,l) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | | M | | | | | | | H |
| | CO 2 | M | | | | M | | | | | | | H |
| | CO 3 | M | | | | M | | | | | | | H |
| | CO 4 | M | | M | | M | | | | | | | H |

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|---|---|
| **Course Content** | **Unit I:**<br>**Production systems:** Continuous and intermittent production. Mass and flow production, batch production, job order production, production functions. Production Planning & Control Functions<br>**Forecasting:** Forecasting variables, forecasting procedure, and methods of forecasting: moving average, least squares, simple exponential smoothing, linear regression, correlation coefficient, problems. |
| | **Unit – II**<br>**Aggregate planning and scheduling:** Long range, intermediate range and short range plans, the aggregate planning problem, aggregate planning strategies<br>**Master scheduling:** Master scheduling formation: inputs and outputs. Master scheduling methods. |
| | **Unit – III**<br>**Materials Management and Inventory Control:** Functions of materials management, purpose of inventories, types of inventories, relevant costs in inventory control, ABC, VED and XYZ analysis.<br>**Economic order quantity (EOQ) models:** Basic EOQ, economic production run length (ERL), quantity discounts, safety stock, problems, P & Q Systems of Control.<br>**Materials requirement planning (MRP):** Importance of MRP and CRP, MRP system |

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| | inputs and outputs, bill of materials, MRP logic, MRPII, Just in Time Production Systems: Just-in-Time System: Evolution, Characteristics of JIT Systems, Continuous Improvement, The Kanban System, Calculation of number of Kanban's Requirements for implementation JIT – benefits of JIT. |
| | **Unit – IV**<br>**Quality control:** Tolerance limits of a process, control charts for variables: X and R charts. Control charts of attributes, p-chart, and c-chart.<br>**Acceptance sampling** – single sampling, double sampling and multi sampling plans for attributes, OC curves, Introduction to TQM, Deming's quality philosophy, Taguchi quality philosophy, introduction to e-Manufacturing. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Operations Management – Joseph G. Monks 3rd Edition TMH,1987<br>2. Industrial Engineering and Production management by MarthandTelsangS.Chand Publications.<br>**Reference Books:**<br>1. Materials Management – Gopalakrishnan and Sudhakaresan<br>2. Quality Control – Dale H. Besterfield,1995 Prentice Hall<br>3. Practical E-Manufacturing and Supply Chain management Gerhard Greeff, RanjanGhoshalOxford ; Burlington, MA : Newnes, Copyright © 2004 Elsevier Ltd. |
| **E-resources and other digital material** | 1.www.transtutors.com<br>2.www.referenceforbusiness.com<br>3.www.prenhall.com<br>4.www.brighthub.com |

## 14ME4802/1 - ROBOTICS

| | | | |
|---|---|---|---|
| **Course Category:** | Program Elective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practice:** | 3 - 1 - 0 |
| **Prerequisites:** | 14ME3306 Kinematics of Machines<br>14ME4704/1 Mechatronics<br>14ME4704/3 Hydraulics & Pneumatic Systems | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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|---|---|---|
| **Course Outcomes** | Upon successful completion of the course, the student will be able to: | |
| | CO1 | Understand the basic components and types of Robots (a) |
| | CO2 | Recognize the Robot end effecter interface and Machine vision functions (a,d,k) |
| | CO3 | Learn the working principles of Robot sensory devices (a,d,k) |
| | CO4 | Develop transformations and kinematics for robot manipulator (a,e) |

**Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)**

| | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | | | | | | | | | | | |
| CO2 | L | | | H | | | | | | | H | |
| CO3 | L | | | H | | | | | | | M | |
| CO4 | H | | | | M | | | | | | | |

**Course Content**

**UNIT – I**

Introduction to Robotics, major component of a robot, robotic like devices, classification of robots – Classification by coordinate system and by control method, Precision of movement, Specifications of robots, fixed versus flexible automation, economic analysis, Overview of robot application.

**UNIT – II**

**Robot end Effectors:** Introduction, end effectors, types of end effectors, grippers, classification of grippers, Gripper mechanisms, Other types of grippers-Vacuum cups, Magnetic grippers, adhesive grippers and miscellaneous types. Tool as end effectors, Interfacing, considerations in gripper selection and design, remote centered devices.

**Machine Vision:** Introduction, Functions of machine vision, applications of machine vision.

**UNIT – III**

**Robotic sensory devices:** Objective, Non-optical position sensors – potentiometers, synchros, optical position sensors – opto interrupters, optical encoders (absolute & incremental).

**Proximity sensors :** Contact type , non contact type – reflected light scanning laser sensors.

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| | **Touch & slip sensors :** Tactile sensors – proximity rod & photo detector sensors, slip sensors – Forced oscillation slip sensor, interrupted type slip sensors<br><br>**UNIT – IV**<br>**Transformations and Kinematics:** Objectives, homogenous coordinates, Transformations - translational & rotational with simple problems.<br>Forward solution -establishing link co-ordinate frames, DenavitHartenberg procedure.<br>**Robot Programming**:Methods of Robot programming,Weight,Signaland Delay Commands,branching in Robot program,Introduction to Robot languages; AL,AML, Robot language structure. |
| **Textbooks and Reference books** | **Text books:**<br>1. Robotic Engineering by Richard D.Klafter, Prentice Hall, Tata Mc Graw-Hill, 1995. 3rd Edition.<br>2. Industrial Robotics by MikellP.Groover, TMH<br>**Reference Books:**<br>1. Introduction to Robotics – John J. Ceaig, Addison Wesley,3rd Edition<br>2. Robotics – K. S. Fu, Gonzalez &Hee, Tata Mc Graw-Hill, 1995. 3rd Edition.<br>**3.** Robotics for Engineers by YoramKoren. Tata Mc Graw-Hill, 1995. 3rd Edition. |
| **E-resources and other digital material** | **Web References:**<br>1. http://nptel.iitm.ac.in/courses.php?branch=Mechanical<br>2. http://academicearth.org/courses/introduction-to-robotics<br>**Video references:-**<br>http://nptel.iitm.ac.in/video.php?courseId=1052 |

**14ME4802/2**

**FLEXIBLE MANUFACTURING SYSTEMS & GROUP TECHNOLOGY**

| | | | |
|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3 –1 - 0 |
| **Prerequisites** | Nil | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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|---|---|---|
| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the concept of Automation, Flexible Manufacturing Systems, FMS architecture and its classifications. (a,d) |
| | CO 2 | Understand the concepts of automated material handling and various automated storage systems. (a,d) |
| | CO 3 | Understand the computer control systems of FMS and concepts of Group Technology. (a,d) |
| | CO 4 | Recognise the different types coding systems and applications of GT. (a,b,d) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | M | | | | | | | | |
| | CO 2 | M | | | M | | | | | | | | |
| | CO 3 | M | | | H | | | | | | | | |
| | CO 4 | M | H | | M | | | | | | | | |

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| **Course Content** | **UNIT I:**<br>**Introduction:** Automation, Need of automation, Basic elements of an automated system, Types of automation, Manufacturing Automation, Components of manufacturing system, classification of manufacturing systems, Introduction to FMS system, Need of flexibility, Concept of flexibility, Types of flexibilities, Architecture of FMS, Components of FMS, Work piece flow in FMS, FMS planning and implementation issues, FMS benefits and applications. |
| | **UNIT – II**<br>**Automated material handling:** Function of Material handling systems, Types of Material handling equipment, Conveyor systems, Automated Guided Vehicles (AGV), Industrial Robots.<br>**Automated storage systems:** Storage System Performance,Storage Location Strategies, Automated storage and Retrieval Systems, Characteristics of Storage Systems. |
| | **UNIT – III**<br>**Computer control system of FMS:** Functions of Computer, Control system architecture, Continuous versus Discrete Control, Computer Process Control, Forms of Computer Process Control, Programmable Logic Controllers, Factory communications, Local area networks. |

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| | **Group Technology:** Introduction, need of Group Technology, Part families, Methods for developing part families. |
| | **UNIT – IV**<br>**Basic type of codes:** Codes and coding systems structures, Hierarchical codes, Poly code, Mixed code, Optiz classification and coding system, KK-3 system, the MICLASS system, Production flow analysis, Group Technology Machine Cells, Advantages and Limitations, Guidelines for implementing Group Technology, Application of GT for design retrieval, CAPP, NIC, MR and FMS. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Automation, Production Systems and Computer Integrated Manufacturing by M.P.Groover, 3rd Edition 2007,Prentice Hall<br>**Reference Books:**<br>1. Performance Modeling of Automated Manufacturing Systems, N. Viswanadham, Y.Narahari.1992 , Prentice hall<br>2. Computer Aided Design and Manufacturing by K. Lalit Narayan, 2008, PHI Pvt. Ltd.<br>3. CAD/CAM Handbook by Eric Teichloz.1985,TMH<br>4. Computer Integrated Design and Manufacturing by Bedworth Henderson,1991, TMH |
| **E-resources and other digital material** | 1. http://www.mechanicalindetail.info/advanced-manufacturing-systems/concept-of-flexible-manufacturing-systems-FMS.htm<br>2. http://www.scribd.com/doc/19321303/Flexible-Manufacturing-SystemsFMS-A-Whitepaper |

## 14ME4802/3 ADVANCED MANUFACTURING MANAGEMENT

| | | | |
|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3- 1 - 0 |
| **Prerequisites** | 14ME3801Manufacturing Management | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

| | | |
|---|---|---|
| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the concepts of e-manufacturing in supply chain management (a,k,l) |
| | CO 2 | Understand the concepts of benchmarking and SQC in TQM. (a,k,l) |
| | CO 3 | Understand the various aspects of production and productivity. (a,k,l) |
| | CO 4 | Familiarize with the basic concepts of cellular manufacturing. (a,k,l) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | | | | | | | | M | H |
| | CO 2 | M | | | | | | | | | | M | H |
| | CO 3 | M | | | | | | | | | | M | H |
| | CO 4 | M | | | | | | | | | | M | H |

| | |
|---|---|
| **Course Content** | **Unit I:**<br>Evolution of manufacturing, Modern developments, E-manufacturing – e-manufacturing and supply chain – business process design models and concepts, Continuous improvement, Process reengineering, basic problem solving and improvement tools, value added focus – sources of waste. |
| | **Unit – II**<br>TQM – framework for managing total quality – employee involvement – benchmarking – quality certification and awards, Statistical process control – variation in processes – process capability- Process Capability Analysis, Process Capability Ratios - Exponentially Weighted Moving Average Control Chart - Moving Average Control Chart -Six sigma quality – methodology. |
| | **Unit – III**<br>Types of Production-Lean production – small lot production –Setup time - setup time reduction – pull production – pull and push systems –kaizen - kaizen and productivity-Implementation of kaizen - technological innovation and productivity improvement-Role of Managers and workers- kanban |
| | **Unit – IV**<br>Focused factories and group technology – ways of doing work – facility layout – part families and machine groups – production flow analysis, Cellular manufacturing – part family/machine cell formation methods– linked cells – work cell design – work |

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| | cell capacity – staffing a work cell. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Nicholas, J., Competitive Manufacturing Management – Continuous Improvement, Lean Production, and Customer-Focused Qualities, McGraw-Hill Edition, 2001.<br>2. Greeff, G., and Ghoshal, R., E-manufacturing and Supply Chain Management, Elsevier, 2004<br><br>**Reference Books:**<br>1. Sing, N., and Rajamani, D., Cellular Manufacturing Systems: Design, Planning & Control, 1sted., Chapman & Hall, 1996.<br>2. Askin, R.G., and Standridge, C.R., Modelling and Analysis of Manufacturing Systems, John Wiley & Sons. Inc, 1993.<br>3. Mikell P. Groover (2001). Automation, Production Systems, and Computer-Integrated Manufacturing, 2 nded., Prentice-Hall of India Private Limited.<br>4. Bedworth, D.D., Henderson, M.R., and Wolfe, P.M., Computer-Integrated Design and Manufacturing, McGraw-Hill International Edition, 1991.<br>5. Chang, T-C, Wysk, R.A., and Wang, H-P,Computer-Aided Manufacturing, 2nd ed., Prentice-Hall International, Inc, 1998. |
| **E-resources and other digital material** | |

## 14ME4802/4 MACHINE TOOL DESIGN

| | | | |
|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3 –1 - 0 |
| **Prerequisites** | 14ME3507 Metal Cutting and Machine Tools<br>14ME3502 Design of MachineElements | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

| | | |
|---|---|---|
| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the types of Machine Tool motions, Cutting tool forces and various types of Machine Tool drives (a,c) |
| | CO 2 | Understand and design Machine Tool gear box and Guide Ways (a,c) |
| | CO 3 | Understand the design of Machine Tool structures and power screws (a,c) |
| | CO 4 | Understand the Machine Tool Vibrations and Lubrication and Rigidity in Machine Tools (a,c) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | H | | | | | | | | | |
| | CO 2 | M | | H | | | | | | | | | |
| | CO 3 | M | | H | | | | | | | | | |
| | CO 4 | M | | H | | | | | | | | | |

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| **Course Content** | **Unit I:**<br>**Introduction:** Working and Auxiliary motions in Machine Tools, Parameters defining the working motions of a machine tool, determination of the forces acting on the tool, determination of the forces acting on the tool in certain machining operations and horse power requirement in lathe. Techno economical pre requisites for undertaking the design of new machine tool, General requirements of machine tool design. Engineering design process applied to machine tools.<br>**Machine Tool Drives:** Classification and choice of driving system, basic considerations in the design of drives, Mechanical and Hydraulic Transmission and its elements, Aim of speed and feed regulation. |
| | **Unit – II**<br>**Design of Gear Box:** Stepped regulation of speed, Design of speed gear box, feed gear box, Machine Tool drives using multiple speed motors, Special cases of gear box design, General recommendations for developing the gearing diagram, Standardization of common ratio, Ray diagrams, Classifications of speed and feed boxes, Step less regulation of speed and feed rates (elementary treatment only).<br>**Machine Tool Guide ways:** Functions and types of guide ways, types of slide ways, |

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| | Types of anti friction ways, Design of slide ways, Shapes of slide ways, Materials of slide ways, Methods of adjusting clearances in slide ways, Design criteria and calculations for slide ways, Design of slide ways for wear resistance, Design of slide ways for stiffness, Effect of lubrication and design of guide ways. |
| | **Unit – III**<br>**Machine Tool Structures:** Function of Machine Tool Structures and their requirements, Design criteria for machine tool structures, profile of machine tool structures, Basic design procedure of machine tool structures, Introduction to design of Beds, Columns and Housings.<br>**Design of Spindle and Power Screws:** Functions of spindle unit and requirements of spindles, Introduction to design of power screws, Design of sliding friction power screw, Design of rolling friction power screws. |
| | **Unit – IV**<br>**Machine Tool Vibrations:** Introduction, forced vibration, self-excited vibration, forced and damped vibrations, stick- slip vibration in machine tools, vibration isolated tool holders.<br>**Lubrication and Rigidity in Machine Tools:** Introduction, Steps in selecting proper lubricating oil, specification of lubricating oil, friction conditions of working, Rigidity of machine tool unit, Overall static rigidity of machine tool, Dynamic rigidity of machine tool. |
| **Text Books and Reference Books** | **Text Books**:<br>**1.** N. K. Mehata, "Machine Tool Design", Tata Mc Graw Hill Publ. Co. Ltd., New Delhi, 1984<br>**2.** S. K. Basu& D. K. Pal, "Design of Machine Tools", Allied Publishers, India.,1965<br>**Reference Books:**<br>1. G. C. Sen and A. Bhattacharyya, "Design and construction of Machine Tools", New Central Book agency, Calcutta.1999<br>2. F. Koenisberger, "Design principles of Metal Cutting Machine Tools", Pergamon Press.1964<br>3. N. Acherkhan, "Machine Tool Design", Vol. 1 & 2 , and 3& 4, M I R Publishers, Moscow. 1969 |
| **E-resources and other digital material** | 1. www.srmuniv.ac.in<br>2. www.jntu.ac.in<br>3. www.iitk.ac.in<br>4. www.vit.edu<br>MIT Video lessons<br>IIT, NPTEL video lessons |

## 14ME4802/ 5: :ADVANCED MANUFACTURING PROCESSES

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| **Course Category:** | Program Elective | **Credits:** | 3 |
| **Course Type:** | Theory | **Lecture - Tutorial - Practice:** | 3-1-0 |
| **Prerequisites:** | 14ME 1107- Mechanics for Engineers<br>14ME 3507 – Metal Cutting and Machine Tools | **Continuous Evaluation:**<br>**Semester End Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

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| **Course outcomes** | Upon successful completion of the course, the student will be able to: | | | | | | | | | | | | |
| | CO1 | Understand the concepts and classification of jigs and fixtures, location and clamping devices (a,c) | | | | | | | | | | | |
| | CO2 | Understand the concepts of production of gears and their finishing processes (a,c) | | | | | | | | | | | |
| | CO3 | Understand the concepts of blow moulding, compression moulding and injection moulding and explosive forming processes (a,c) | | | | | | | | | | | |
| | CO4 | Understand the concepts of automation and their types (a,c) | | | | | | | | | | | |
| **Contribution of Course outcomes towards achievement of Program Outcomes (L – Low, M - Medium, H – High)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
| | CO1 | M | | M | | | | | | | | | |
| | CO2 | M | | M | | | | | | | | | |
| | CO3 | M | | M | | | | | | | | | |
| | CO4 | M | | M | | | | | | | | | |
| **Course Content** | **Unit I:**<br>**Jigs and Fixtures:** Introduction, differences between jigs and fixtures, design considerations of Jigs and fixtures, principles of location, location of a rectangular block, location of a cylinder, locating devices, principles of clamping, clamping devices, types of clamps, types of drilling jigs, jig bushes, turning fixtures, milling fixtures, welding fixtures.<br><br>**Unit II:**<br>**Gear Manufacturing:** Gear materials, Types of gear manufacturing, gear generation and forming principles, Advantages and limitations of gear milling, Gear broaching, Gear Shaping, Gear Hobbing, Types of Gear Hobbing.<br>Gear Finishing Methods: Gear burnishing, gear shaving, gear honing, gear lapping, and gear grinding processes.<br>**Thread Manufacturing:**Thread chasing, Thread milling thread rolling, grinding, tapping, and thread cutting on lathe.<br><br>**Unit III:**<br>**Processing of Plastics:**Blow moulding, compression moulding, and Injection moulding, equipment details, their applications and advantages and limitations. | | | | | | | | | | | | |

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| | **Explosive Forming process:**Introduction, principle of explosive forming, components, types, various approaches, applications, advantages, limitations of explosive forming.<br><br>**Unit – IV:**<br>**Automation:**Introduction, Production Systems, Automation in Production Systems, Reasons for Automation, Automation Principles and Strategies, Basic elements of an Automated System, Levels of Automation, Classification of Automatic Machines, Single Spindle Automatics and Multi Spindle Automatics, General Terminology and Analysis of Transfer Lines without storage, Automated Flow Lines with storage buffers. |
| **Textbooks and Reference books** | **Text Books:**<br>1. P. C. Sharma, "Production Technology", 7th Edition, S. Chand & Company, 2008.<br>2. P. N. Joshi, "Jigs and Fixtures", 3rd Edition, Tata Mc- Graw Hill Publishers, 2010.<br>**Reference books:**<br>1. Mikell P. Groover, "Automation, Production Systems and CIM", Prentice Hall of India, 2nd Edition, New Delhi, 1995.<br>2. Donaldson, "Tool Engineering", 3rd Edition, Tata Mc- Graw Hill Publishers, 2010.<br>3. Kempster, "An Introduction to Jig and Tool Design", 3rd Edition, Viva Books Pvt. Ltd., 2008.<br>4. H M T,"Production Technology", 28th Reprint, Tata Mc- Mc Graw Hill Publishers, 2008. |
| | **Web resources:**<br>1. http://nptel.iitm.ac.in<br>2. www.jntu.ac.in<br>3. www.iitm.ac.in<br>Video Lessons:<br>1. MIT video lessons.<br>2. IIT video lessons.<br>3. NPTEL video lessons. |

## 14ME4803/1 –ENERGY CONVERSION & MANAGEMENT

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| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3-1 - 0 |
| **Prerequisites** | 14ME3404 Applied Thermodynamics<br>14ME3504Internal Combustion Engines | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the fundamental concepts of steam& Hydro power plant (a) |
| | CO 2 | Understand the working principle of various energy conversion systems (a) |
| | CO 3 | Identify different non-conventional energy resources and their utilization (a,h,j) |
| | CO 4 | Understand economics of power generation & energyaudiing (a,l) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | | | | | | | | | |
| | CO 2 | H | | | | | | | | | | | |
| | CO 3 | H | | | | | | | H | | H | | |
| | CO 4 | M | | | | | | | | | | | H |

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| **Course Content** | **Unit I:**<br>**Steam power plant:** Typical layout of steam power plant, material requirement for thermal power plant, site selection, coal handling,ash handling, draught, coal analysis, pulverized coal firing system,electrostatic precipitator, deaeration, cooling ponds and cooling towers<br>**Hydroelectric power plant:** Site selection, advantages, disadvantages, hydrological cycle, hydrographs, storage, pondage, essential elements of hydro plant, classification |
| | **Unit – II**<br>**Diesel and gas turbine power plants:** applications of diesel engine plant, advantages and disadvantages, general layout,closed and open gas turbine plants, advantages and disadvantages, Gas turbine fuels<br>**Nuclear power plants:** nuclear fission, chain reaction, types of reactors -Pressurized water reactor, boiling water reactor, liquid metal Fast Breeder reactor |
| | **Unit – III**<br>**Solar energy:** solar thermal conversion, solar thermal power generation photo voltaic conversion.<br>**Wind energy:** basic components of wind energy conversion systems,Classification of wecs, types of wind machines |

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| | **Energy from Bio-mass:** introduction, basic conversion technologies<br>**Geo-thermal energy**: geothermal sources, hydrothermal resources,Vapor dominated systems, liquid dominated systems.<br>**Energy from ocean:** ocean thermal energy conversion systems,Open cycle OTEC system, closed cycle OTEC system.<br>**Direct energy conversion systems:** principle operation of a fuel cell (with reference to h2,o2 cell), principle of MHD Power generation. |
| | **Unit – IV**<br>**Energy Management:**<br>**Power Plant Economics:**Introduction, Load duration curves, Various performance factors (load factor, diversity factor, use factor etc..), operating costs, effect of load factor on cost per KWh.<br>**Energy Auditing:** level of responsibility – control of energy, energy conservation schemes – energy index – cost index – pie charts – sankey diagrams – load profiles – energy auditing– general energy auditing-detailed energy audits. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Power Plant Engineering- P.K.Nag – Tata McGraw hill , 3rd Edition.<br>2. Non ConventionalEnergyResources - G.D.Rai -khanna publications 4th Edition<br>3. Energymanagement-W.R.MURPHY& G.MICKAY<br>**Reference Books:**<br>1. Power Plant engineering- - ARORA,DOMAKUNDWAR,DHANPATRAI & CO 2010<br>2. Power Plant Technology - M.M. EL Wakil TMH, 1984<br>3. Principles of Energy Conversion - A.W.Culp, TMH,1979<br>4. Waste heat recovery systems-D.A.Reay-Pergmon press<br>5. Hand book of energy audits-Albert Thuann |
| **E-resources and other digital material** | 1. en.wikipedia.org/wiki/Thermal_power_station<br>2. www.world-nuclear.org/info/inf32.html |

## 14ME4803/2 AUTOMOBILE ENGINEERING

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|---|---|---|---|
| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3 –1 - 0 |
| **Prerequisites** | 14ME3504 Internal CombustionEngines | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the working of engine components, trouble-shooting & maintenance procedures. (a,I,j,k) |
| | CO 2 | Understand the working of automobile cooling, lubrication and electrical systems. (a,d,i,j) |
| | CO 3 | Understand the working of automobile transmission system components. (a,i,j) |
| | CO 4 | Understand the working of automobile vehicle suspension and control systems. (a,i,j) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | | | | | | M | M | M | |
| | CO 2 | M | | | M | | | | | M | M | | |
| | CO 3 | M | | | | | | | | M | M | | |
| | CO 4 | M | | | | | | | | M | M | | |

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| **Course Content** | **Unit I:**<br>**Introduction:** Classification of vehicles, applications, transmission arrangements.<br>**Engine Components:** Engine construction, combustion chambers for petrol and diesel engines, Pistons, DTSI, valve arrangements and operating Mechanisms (SOHC & DOHC), firing order, crankshaft, flywheel.<br>**Engine Servicing and Maintenance:** Engine trouble-shooting, engine testing procedures and instruments used, engine tests, reconditioning of engine components – valve seat boring, reboring, crankshaft grinding. |
| | **Unit – II**<br>**Cooling systems for I.C. Engines:** Need for cooling system, air cooling and water cooling - thermo-syphon and forced circulation, radiator, thermostat, antifreeze solutions.<br>**Lubricating systems for I.C. Engines:** Petrol, splash, pressure & dry sump lubrication systems, oil filters, crankcase ventilation.<br>**Electrical system for I.C. Engines:** Ignition systems – battery-, magneto- & electronic Ignition, spark plugs, alternator, cutout, current and voltage regulators, Starting motors - Bendix drive mechanism, lighting, instruments and accessories. |
| | **Unit – III**<br>**Transmission system:** Introduction to chassis & transmission, clutches – single-plate- multi- |

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| | plate , diaphragm and centrifugal clutches, clutch actuating mechanisms.<br>**Gear boxes and others:** Gear Box types - four speed and five speed sliding mesh, constant mesh & synchromesh type, selector mechanism, automatic transmission, overdrive, propeller shaft, differential. |
| | **Unit – IV**<br>**Suspension systems:** Need for suspension systems, springs, shock absorbers, axles – front and rear, different methods of floating rear axle, front axle and wheel alignment<br>**Vehicle control:** Steering mechanisms and power steering, types of brakes and brake actuation mechanisms (air and hydraulic), Disc brakes, anti-lock braking system, Air bags, types of tyres. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Automobile Engineering – Vol. I & II - Kirpal Singh, 1st edition, 2009, Standard Publishers.<br>**2.** Automobile Engineering - R.B. Gupta, 3rd edition 1982, Satya Prakashan.<br>**Reference Books:**<br>1. Automobile Engineering - G.B.S. Narang, 5th edition, 1989, Khanna Publishers.<br>2. Automotive Mechanics - Joseph Heitner 2nd Edition, 1967, Van NastrandRehinhold.<br>3. Automotive Mechanics – William H. Crouse, D.L. Anglin, 1982, Tata McGraw hill. |
| **E-resources and other digital material** | • www.gec.ac.in/~bsm/automobile/automobile.html<br>• http://auto.howstuffworks.com/engine2.htm<br>• www.carbibles.com/steering_bible.html<br>• www.educypedia.be/education/carjava.htm |

## 14ME4803/3 CRYOGENIC ENGINEERING

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| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3 –1 - 0 |
| **Prerequisites** | 14ME3504 Basic Thermodynamics<br>14ME3601 Heat Transfer<br>14ME3703 Refrigeration and Air Conditioning | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the mechanism of variation of properties of materials at low temperatures. (a) |
| | CO 2 | Apply the laws of thermodynamics to analyze the gas liquefaction systems. (a,c,e) |
| | CO 3 | Apply the laws of thermodynamics to analyze the low temperature gas separation systems. (a,c,e) |
| | CO 4 | Understand the use of effective and environmentally safe cryogenic technology for applications in space, medicine and agriculture. (f,h,I,j) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | | | | | | | | | |
| | CO 2 | H | | M | | M | | | | | | | |
| | CO 3 | H | | M | | M | | | | | | | |
| | CO 4 | | | | | | L | | L | M | M | | |

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| **Course Content** | **Unit I:**<br>**Introduction to Cryogenic systems:** Introduction, Historical development, present areas involving cryogenic engineering. Basic thermodynamics as applied to liquefaction and refrigeration process.<br>**Low temperature properties of engineering materials:** Mechanical properties, thermal properties, Electrical and magnetic properties. Properties of cryogenic fluids. |
| | **Unit – II**<br>**Gas Liquefaction systems:** Systems performance parameters, thermodynamically ideal system, Joule-Thomson effect, adiabatic expansion, Simple Linde- Hampson system, pre cooled Linde- Hampson system, Linde dual pressure system, Claude system, Kapitza system. |
| | **Unit – III**<br>**Gas separation systems:** Thermodynamically ideal separation system, Simple condensation or evaporation, Principles of rectification, types of rectification columns.<br>**Air separation systems:** Linde single column system, Linde double column system, Lindefrankl system, Hylandt system. |

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| | **Unit – IV**<br>**Applications of cryogenics:**Cryo pumping, Super conductivity, Super fluidity, Cryogenics in space technology, Cryogenics in biology and medicine, Cryogenics in living organisms, Cryogenics in construction industry, Cryogenics in agriculture. |
| **Text Books and Reference Books** | **Text Books**:<br>1. Randall F. Barron - Cryogenic Systems, McGraw Hill.<br>2 . Mukhopadhyay**,** Mamata - Fundamentals of Cryogenic Engineering **,**PHI<br>**Reference Books:**<br>1. Scott R.B. – 'Cryogenics Engineering', Van Nostrand& Co.<br>2. Sengapatha, Bose A., 'Cryogenics – Progress and Applications', Tata McGraw Hill<br>3.Timmerhaus, K. D. and Flynn, T. M., 'Cryogenic Process Engineering', Plen Press. |
| **E-resources and other digital material** | • nptel.ac.in/courses/112101004/<br>• http://www.myopencourses.com/subject/cryogenic-engineering<br>• http://www.slac.stanford.edu/econf/C0605091/present/CERN.PDF<br>• http://www.nptelvideos.in/2012/12/cryogenic-engineering.html |

## 14ME4803/4 GAS DYNAMICS

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| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3- 1 - 0 |
| **Prerequisites** | 14ME3303 Basic Thermodynamics<br>14ME3403 Fluid Mechanics | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the physical origin of equations of compressible 1-D flows. (a) |
| | CO 2 | Analyze 1-D flows including shock waves, heat addition and friction. (a,c,e) |
| | CO 3 | Understand the concept of Mach number and how it relates to compressibility effects, typical flow properties and wave propagation. (a,c) |
| | CO 4 | Understand and analyze the effect of shock waves on compressible flows. (a,c) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | H | | | | | | | | | | | |
| | CO 2 | H | | M | | M | | | | | | | |
| | CO 3 | H | | L | | | | | | | | | |
| | CO 4 | H | | H | | | | | | | | | |

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| **Course Content** | **Unit I**<br>**Definitions and Basic Relations:** Energy equation for a flow processes, stagnation-pressure, density, temperature, velocity, Mach number, effect of mach number on compressibility.<br>**Rate Equations for a Control Volume:** Continuity equation, Navier stokes equations, aerofoil theory, boundary layer, boundary layer separation criterion. |
| | **Unit – II**<br>**Isentropic Flow With Variable Area:** Comparison of isentropic and adiabatic processes, Mach number variation stagnation and critical states, area ratio as function of Mach number, mass flow rate, flow through nozzles.<br>**Flow With Friction:** flow in constant area duct with friction- Fanno Line, Fanno flow equations,Variation of flow properties, variation of Mach number with duct length |
| | **Unit – III**<br>**Flow With Heating or Cooling in Ducts:** Governing equations, Rayleigh curve, Rayleigh flow relations, heating in subsonic and supersonic flows.<br>**Flow With Normal Shock Waves:** Development of a shock wave, governing equations, Pandtl-Meyer relation, Static pressure, temperature and density (the Rankine-Hugoniot equations) ratios across the shock waves, determination of Mach number of supersonic flows. |

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| | **Unit – IV**<br>**Flow With Oblique Shock Waves:** Nature of flow through oblique shock waves, fundamental relations, Prandtl's equation, Rankine-Hugoniot equation, variation of flow parameters, oblique shock relation from the normal shock equations.<br>**Methods of Measurement:** Pressure measurement, Temperature, Density, Velocity, Hot-wire anemometer, Wind tunnels. |
| **Text Books and Reference Books** | **Text Books**:<br>1. S.M.Yahya, "Compressible Flow", 4th Edition New age science 2009<br>2. E.Radhakrishnan, Gas Dynamics, PHI Publishers,5th printing,2005.<br>**Reference Books:**<br>1. John D.Anderson, Jr. "Modern Compressible Flow", 2nd Edition,1990 McGraw-Hill<br>2. Camhel and Jennings, "Gas Dynamics", McGraw-Hill |
| **E-resources and other digital material** | 1. http://www.adl.gatech.edu/classes/gasdyn/gasdyn01.html<br>2. http://web.ics.purdue.edu/~alexeenk/GDT/index.html<br>3. http://www.nd.edu/~powers/ae.360/notes.pdf<br>4. Books available at college web 152.152.1.100 |

## 14ME4803/5 – SOLAR ENGERY UTILIZATION

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| **Course Category** | Program Elective | **Credits:** | 3 |
| **Course Type** | Theory | **Lecture – Tutorial – Practice** | 3- 1- 0 |
| **Prerequisites** | 14ME3303Basic Thermodynamics, 14ME3404 Applied Thermodynamics | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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| **Course Outcomes** | Upon successful completion of the course, the student will be able to | |
| | CO 1 | Understand the solar radiation data and its measurement (a) |
| | CO 2 | Understand the principles of solar energy collection and devices (a,c) |
| | CO 3 | Understand types of Thermal energy storage systems and their applications (a,h,j) |
| | CO 4 | Understand power generation using PV principles and design of PV systems. (a,c,h,j) |

| **Contribution of Course Outcomes towards achieve-ment of Program Outcomes (H- High, M –Mediun , L- Low)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CO 1 | M | | | | | | | | | | | |
| | CO 2 | M | | M | | | | | | | | | |
| | CO 3 | M | | | | | | | M | | M | | |
| | CO 4 | M | | M | | | | | M | | M | | |

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| **Course Content** | **Unit I:**<br>**Introduction**: Applications of Solar Energy, Solar energy utilization in India<br>Solar Radiation: Solar constant, Solar time, Solar angle.<br>Radiation measurement and devices, Solar radiation data, estimation of average solar radiation on tilted and horizontal surfaces. |
| | **Unit – II**<br>**Flat Plate Collector:** Description, performance analysis of FPC, Collector efficiency, overall loss coefficient, heat removal factor.<br>Effect of absorber coatings, dust, shading on the performance of collector, selection of materials for FPC.<br>**Focusing Collectors:** Types of concentrating collectors, Orientation and tracking systems, materials for concentrating collectors. |
| | **Unit – III**<br>**Thermal Energy Storage:** Types, Sensible and Latent heat storage, Electrical, chemical and hydro storage of solar energy. Solar Pond- principle, description, extraction of thermal energy, types and application of solar ponds.<br><br>**Other Applications:** Solar water heating, natural and forced circulation heaters, series and parallel array, solar cooling systems, Solar thermal power generation, solar furnace, solar |

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| | pumping, production of hydrogen.<br>Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage |
| | **Unit – IV**<br>**Solar Photo Voltaic:** Solar cell principle, PV cell, efficiency, cell materials,Solar PV systems for power generation- stand alone, grid type and hybrid, Solar cell modules, design of PV system, Applications of SPS, advantages and disadvantages of solar PV systems. |
| **Text Books and Reference Books** | **Text Books:**<br>1. Solar energy utilization - G.D. Rai, Khanna Publishers, 4th ed., 2009.<br>2. Solar energy - Sukhatme S.P., TMH., 3rd ed.,2008<br>3. Solar engineering of thermal processes - Duffie J.A. and Beckman W.A.,4th ed., 2001.<br>**Reference Books:**<br>1. Non-conventional Energy resources - S.K. Dubey, S.K. Bhargava,Dhanpatrai publications, 1stEdition, 2009<br>2. Principles of solar engineering - D.Y. Goswami, F. Kreith and J.F.<br>3. Kerider, Taylor& Francis publishers,USA, 2nd edition, 2008<br>4. Fundamentals of solar energy conversion - Edward E.Anderson, 1st Ed. |
| **E-resources and other digital material** | 1. science.howstuffworks.com/...vs.../what-are-some-practical-uses-for-solar energy.htm<br>2. solarpowernotes.com/solar-energy-applications.html<br>3. www.seci.gov.in/<br>4. www.makeinindia.com/sector/renewable-energy<br>5. www.renewableenergyworld.com/solar-energy/tech.html<br>6. https://www.nrel.gov/workingwithus/re-solar.html |

## 14ME 3851 COMPUTER AIDED ENGINEERING LAB

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| **Course Category** | Program Core | **Credits:** | 2 |
| **Course Type** | Laboratory | **Lecture – Tutorial – Practice** | 0 - 0 - 3 |
| **Prerequisites** | 14ME3701 Finite Element Method<br>14ME3702 Computer Aided Manufacturing | **Continuous Evaluation:** | 30 |
| | | **Semester End Evaluation:** | 70 |
| | | **Total Marks:** | 100 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course outcomes** | | Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **Computer Aided Design Laboratory** | **CO1** | Simulate simple static structural problems for stress analysis (a,b,e,i,k) | | | | | | | | | | | |
| | **CO2** | Analyze thermal problems for thermal stress analysis (a,b,e,i,k) | | | | | | | | | | | |
| | **CO3** | Understand forced vibration & dynamic analysis with forcing functions (a,b,e,i,k) | | | | | | | | | | | |
| | **CO4** | Understand Laminar fluid flow analysis usingutility of the tools ANSYS or FLUENT (a,b,e,i,k) | | | | | | | | | | | |
| **Computer Aided Manufacturing Laboratory** | **CO5** | Understand and prepare part programs for turning and milling operations using FANUC (OT & MT) simulation software (a,k) | | | | | | | | | | | |
| | **CO6** | Understand and perform Pick and Place operations and moving the robot arm along a defined path using SCORBOT ER 4u Robot (a,k) | | | | | | | | | | | |
| | **CO7** | Understand and perform 3D model by using modelling software and develop the part on rapid prototyping machine (a,k) | | | | | | | | | | | |
| **Contribution of Course Outcomes towards achievement of Program Outcomes**<br><br>**(L – Low, M- Medium, H – High)** | | PO a | PO b | PO c | PO d | PO e | PO f | PO g | PO h | PO i | PO j | PO k | PO l |
| | **CO1** | L | H | | | M | | | | H | | M | |
| | **CO2** | L | H | | | M | | | | H | | M | |
| | **CO3** | L | H | | | H | | | | H | | M | |
| | **CO4** | L | H | | | M | | | | H | | M | |
| | **CO5** | L | | | | | | | | | | H | |
| | **CO6** | L | | | | | | | | | | H | |
| | **CO7** | L | | | | | | | | | | H | |
| **Course Content** | **Computer Aided Design:**<br>Finite Element Analysis using analysis package (ANSYS)<br>1. Introduction of ANSYS tools, its utilities and fundamentals of FEM.<br>2. Structural analysis of bars (Stepped bar, Tapered bars, Trusses). | | | | | | | | | | | | |

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| | 3. Structural analysis of beams (Cantilever, Simply Supported, Fixed).<br>4. Structural analysis of plates and cylinders (Thick cylinders, plate with circular hole).<br>5. Thermal analysis of thick cylinders.<br>6. Coupled analysis of thick cylinders.<br>7. Modal Analysis of Cantilever beam for natural frequency determination.<br>8. Harmonic Analysis of Cantilever beam.<br>9. Dynamic analysis of bar subjected to forcing function.<br>10. Laminar Flow Analyses in a 2-D Duct.<br><br>**Computer Aided Manufacturing:**<br><br>1.Manual Part Programming<br>a. Step turning<br>b. Taper turning<br>c. Linear & Circular interpolation<br>d. Mirror imaging<br>2.Material Handling<br>Pick and place programming with robot.<br>3.Additive manufacturing<br>3D model development of Hexagonal bolt and nut assembly using rapid prototyping machine. |

## 14ME5852 - MAJOR PROJECT

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|---|---|---|---|
| **Course Category:** | Independent Learning | **Credits:** | 10 |
| **Course Type:** | Practical | **Lecture - Tutorial - Practice:** | 2 - 6-10 |
| **Prerequisites:** | | **Continuous Evaluation:**<br>**Semester end Evaluation:**<br>**Total Marks:** | 30<br>70<br>100 |

**Course Outcomes:**At the end ofthe course thestudentswill be ableto

CO1:Get exposure to research and development.(a,b,e,f,h,k)

CO2: Generate and implement innovative ideas for social benefit.(a,f,h,k)

CO3: Develop Algorithms / Programs.(a,e,k)

CO4: Develop prototype / models.(a,b,d,k)

CO5: Solve the industrial problems at various stages.(a,b,e,f,h,k)

CO6: Publish/present research papers in national/international journals & conferences (a,b,e,f,g,i,k)