

Metric 1.1.2 & 1.2.2

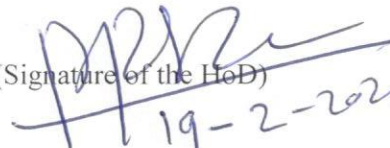
Department: Mechanical Engineering

1.1.2 Percentage of programmes where syllabus revision was carried out during the last five years (20)

1.2.2 Percentage of programs in which Choice Based Credit System (CBCS)/elective course system has been implemented (20)

| Programme Code | Programme Name | Year of Introduction | Status of implementation of CBCS / elective course system (Yes/No) | Year of implementation of CBCS / elective course system | Year of revision (if any) | If revision has been carried out in the syllabus during last 5 years, Percentage of content added or replaced |
|----------------|--|----------------------|--|---|---------------------------|---|
| MT0412 | M.Tech. in Mechanical Engineering (Energy Technology) | 2010 | Yes | 2018 | 2018 | 93 |
| MT0212 | M.Tech. in Mechanical Engineering (Design of Mechanical Equipment) | 1976 | Yes | 2018 | 2018 | 88 |
| MT0312 | M.Tech. in Mechanical Engineering (Computer Aided Analysis & Design) | 1998 | Yes | 2018 | 2018 | 40 |
| MT0112 | M.Tech. in Mechanical Engineering (Heat Power) | 1964 | Yes | 2018 | 2018 | 42 |
| BT0112 | B.Tech. (Mechanical Engineering) | 1955 | Yes | 2018 | 2018 | 37 |

(Signature of the HoD)


19-2-2020

Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI

May 1, 2018.

| |
|-------------------------------|
| Mechanical Engg. Dept. |
| Ref No. <u>1646</u> |
| Date of Issue <u>1.5.2018</u> |

To

Dean, Academic Programme
Birla Institute of Technology
Mesra, Ranchi

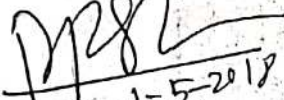
Sub: CBCS Syllabus for B.Tech. and M.Tech.

Dear Madam,

Enclosed please find the hard copy of CBCS syllabus for B.Tech., M.Tech. (Heat Power Engg.), M.Tech. Design of Mechanical Equipments), M.Tech. (Energy Technology) and M.Tech. CAAD) along with Minutes of Board of Studies Member (Internal & External).

Thanking you,

Yours sincerely,


1-5-2018
(Dr. R.P. Sharma)
Professor and Head

DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA RANCHI

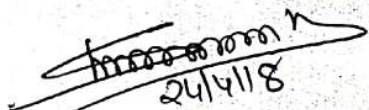
Date 24.04.2018

Minutes of the Board of studies committee (BOS) HELD ON 24.04.2018 AT 11 AM for
CBCS Syllabus

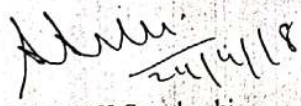
A meeting of the Board of Studies (BOS) was held in CAD lab of the department on April 24th 2018 at 11 AM, for the approval of CBCS proposed syllabus of B.Tech (Mech Engg), B. Tech (Hons), M.Tech (Heat Power Engg), M.Tech (Energy Tech), M.Tech (CAAD), M.Tech (Design of ^{Mechanical} Equipments). The syllabus was discussed and scrutinized by the committee members following conclusion was taken

1. The content volume of the syllabus are adequate and of standard level.
2. The BOS members recommends the proposed syllabus for further processing.

External Members of BOS



24/4/18
Dr. Shailendra Kumar

Professor, Deptt. Of Mechanical Engg
N.I.T.Jamshedpur


24/4/18
Prof. (Dr) S.K. Samdarshi
Centre for energy Engineering
CJU, Brambe Ranchi



Mr. Deepak Mishra
Head Supplier Quality
Tata Motors Ltd Jamshedpur India


Sri. Amit Kumar Pande
Sr. DGM USHA MARTIN
TatiSilwai Ranchi

Internal Member of BOS (Mechanical Engineering)


24.4.18

(Dr. D.P. Mishra)
Member



(Dr. Kaushik Kumar)
Member



(Dr. A.K. Roy)
Member



(Dr. Rajeev Kumar)
Member



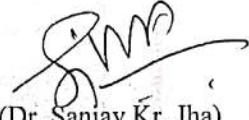
(Dr. Dhaneshwar Mahto)
Member



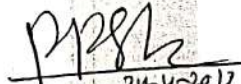
(Dr. Praveen Mishra)
Member

*

(Dr. Anand Kumar Sinha)
Member



(Dr. Sanjay K.R. Jha)
Member


24-4-2017
(Dr. R.P. Sharma)
Chairman & HOD

* on CL

SUGGESTION OF BOS MEMBERS TO IMPROVE CBCS 2018 SYLLABUS

M.TECH – ENERGY TECHNOLOGY

1. Solar Thermal Conversion, Energy management and audit, Energy storage technology, Energy simulation and modelling, Energy resource planning should be there in the course.
2. Hydro power should be presented in a separate module in MT571.
3. From MT575 energy storage system should be removed.
4. Add N.K. Bansal book as reference in MT579.
5. Add hydrogen transport in MT581.
6. Add energy policy in Energy management and audit syllabus.
7. Add agro chemical conversion in MT589.
8. Add entire module of nuclear reactor types in MT591.

Am,
24/4/18

~~Prasanna~~
24/4/18

Prasanna
24/4/18

Dr. D.P. Mishra
24/4/18

Dr.
24.4.18

(Dr. D.P. Mishra)

Suggestions of BOS Members to Improve CBCS 2018 Syllabus

M. E. – Design of Mechanical Equipment

1. ME541 - Advanced Mechanics of Solids should be in First Semester
2. ME537 - Theory of Elasticity in second semester
3. ME539 - Advanced Dynamics and Vibration should be renamed as Applied Dynamics and Vibration.
4. ME541 - should include Advanced Mechanics of Materials by H. Ford and J. M. Alexander as reference book.
5. Torsion of noncircular shafts, photo elasticity, and membrane analogy should be included in the syllabus of Advanced Mechanics of Solids
6. Module 5 of ME541 - Advanced Mechanics of Solids should be changed. It is already taught in Fracture Mechanics course, which is a compulsory course in the program.
7. In module 4 of ME543 - Fracture Mechanics syllabus, 'stationary' term should not be there in title.
8. In module 1 of ME545 - Automatic Control syllabus, PID control and PLC should be included.
9. Concept of bathtub curve should be included in ME623 - optimization techniques syllabus.
10. Concept of Genetic Algorithm in ME623 - optimization techniques should be included in the syllabus.
11. Module 3 of ME 585 - Advanced Engineering Materials syllabus should be updated.

~~Prasanna K~~
24/4/18

~~Prasanna~~
24/4/18

~~Prasanna~~
24/4/18

~~Prasanna~~
24/4/18

~~Prasanna~~
24.4.18

(Dr. D. P. Mishra)

SUGGESTION OF BOS MEMBERS TO IMPROVE CBCS 2018 SYLLABUS

M. E. – CAAD (Mechanical Engineering)

1. All the common courses of different specializations of the department may be merged viz. *finite element analysis, optimization techniques etc.*
2. *Reverse engineering* may be replaced by *advanced mechanical engineering design*.
3. Course title "*Tribology in design*" may be renamed to "*Applied tribology*".
4. A course on *computer graphics* may be included in the program as an elective paper.
5. In computer integrated manufacturing, the fourth module title "Flexible manufacturing system and automated guided vehicle" may be changed to "Flexible manufacturing system and others".
6. Concept of genetic algorithm should be included in "*Advanced optimization technique*".
7. Concept of bathtub curve should also be included in "*Advanced optimization technique*".

AMM
24/4/18

~~Professor~~
24/4/18

Jonker
24/4/18

Adarsh
24/4/18

DP
24.4.18

(Dr. D. P. Mishra)

Suggestions of BOS Members to improve syllabus of M.E. Heat Power Engineering (CBCS) 2018

1. Modify the subject name from Convection heat and mass transfer to Convective heat and mass transfer.
2. Year publications should be incorporated in the books reference list.
3. In the syllabus of renewable energy sources, Hydro energy should be incorporated and Non-Conventional Energy Sources, G.D. Rai, Khanna Publications, New Delhi, 2011 should be omitted from reference book list as it has number of typological errors.
4. Incorporate the name of book principles of solar energy D. Yogi Goswami in Renewable energy sources.
5. Modify contents like thermos ionic to thermof-ionic in modern power Plant Engineering syllabus.
6. Module V of Design and Analysis of Heat Exchangers to be modified.
7. Suggested to remove some words like solar radiation, one dimensional steady state from the subject Advanced refrigeration and air conditioning.

AMM
24/4/18

~~Prasanna~~
24/4/18

Prasanna
24/4/18

Dr. Jay
24/4/18

Dr. J.P. Michr
24-4-18
(Dr. J.P. Michr)

SUGGESTION OF BOS MEMBERS TO IMPROVE CBCS 2018 SYLLABUS

B.TECH – MECHANICAL ENGINEERING

1. The total credits in first and second semester are quite high (AICTE indicates less than 20 credits in each semester)
2. Program core subjects should have more credits than non- program core.
3. Tutorials should have been added in Program core subjects.
4. Laboratories should have less credit.
5. CAD laboratory should be in the 6th semester.
6. ME 402 Computer Aided Machine Drawing can be renamed as Computer Aided Design.
7. Project work should be given more time and it should be included in Seventh Semester as well.
8. ME 337 Industrial Management (Prog Elective –II) should have been made as compulsory paper.
9. Engineering Economics course should be introduced as a compulsory paper.
10. Entrepreneurship Development Course, Total Quality Management etc., could have been included in the course.
11. ME 351 Computational Fluid Mechanics (Prog Elective-III) – should have been made as compulsory paper.
12. ME 433 Design, Modelling and Application of Solar Energy (Prog Elective – IV) – The title should be renamed as Design & Modelling of Solar Systems.
13. Open electives should not have any pre requisite subjects.
14. ME 102 Engineering Graphics (First Semester) – One period of lecture as theory should be included the Laboratory course (1+3 instead of 0+4).
15. ME 205 Strength of Materials (3rd Semester) – Syllabus should include Torsion component.
16. ME 207 Kinematics and Dynamics of Machines (4th Semester) – Mechanism and vibration components should be included.
17. Individual Subject content is vast with reference to the allotted time.

Adnan
24/4/18

~~*Adnan*~~
24/4/18

Adnan
24/4/18

Adnan
24/4/18

Dr. D.P. Mishra
24.4.18
(Dr. D.P. Mishra)

DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI

ME 1202 ENGINEERING GRAPHICS

Sheet No. 1A:

Lines and Lettering

Sheet No. 1B:

Projection of points (6 Hours)

Sheet No. 2:

Projections of Straight Lines. (6 Hours)

Sheet No. 3:

Projections of Planes (5 Hours)

Sheet No. 4:

Projections of Solids. (7 Hours)

Sheet No. 5:

Section of solids (6 Hours)

Sheet No. 6

Isometric Projections (6 Hours)

Sheet No. 7:

Development of Surfaces (6 Hours)

Sheet No. 8:

Intersection of surfaces (6 Hours)

48 Hours.

Books:

1. Engineering Drawing – Dhananjay A. Jolhe.
2. Engineering Graphics – N.D. Bhat

(ME 102) Engineering Graphics Lab

Syllabus

Module 1: Introduction to orthographic projections, Conventions, Fundamentals of First and Third Angle projection, Orthographic projections of points, lines and planes. (9L)

Module 2: Projections of simple solids - axis perpendicular to HP, VP and inclined to one or both planes, Sectioning of solids, section plane perpendicular to one plane and parallel or inclined to other plane. (9L)

Module 3: Development of surfaces- Development of prisms, pyramids and cylindrical & conical surfaces, Isometric projection and isometric views of different planes and simple solids, introduction to perspective projection. (9L)

Module 4: Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing Dimensions. (9L)

Module 5: Create views of engineering parts in AutoCAD, case studies with examples of Mechanical/ Electrical/Civil engineering drawings. (9L)

Text Books

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.
2. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

Reference Books

1. Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|------------------------------------|-------------------------------------|
| Progressive evaluation | 60 |
| End Semester Lab Examination Marks | 40 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|------------------------------------|-----|-----|-----|-----|-----|
| Progressive evaluation Marks | √ | √ | √ | √ | √ |
| End Semester Lab Examination Marks | √ | √ | √ | √ | √ |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping between Objectives and Outcomes

Mapping of Course Outcomes onto Program Outcomes

| Course Outcome | Program Outcomes | | | | | | | | | | | |
|----------------|------------------|---|---|---|---|---|---|---|---|----|----|----|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| CO1 | 3 | 3 | 2 | 3 | 1 | | | 3 | 3 | 3 | | |
| CO2 | 3 | 3 | 2 | 3 | 1 | | | 3 | 3 | 3 | | |
| CO3 | 3 | 3 | 2 | 3 | 1 | | | 3 | 3 | 3 | | |
| CO4 | 3 | 3 | 2 | 3 | 3 | | | 3 | 3 | 3 | | |
| CO5 | 3 | 3 | 2 | 3 | 3 | | | 3 | 3 | 3 | | |



Professor & Head
 Department of *...* Eng
 Birla Institute of Technology
 MESRA, RANCHI-835215

DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI

ME 2001: Principles of Mechanical Engineering

Module – 1: Non-Conventional Energy and their resources: Energy sources; Renewable and Non-renewable Energy Resources; Advantages and Disadvantages of Renewable Resources; Renewable Energy Forms and Conversion; Solar Energy; Wind Energy; Tidal Energy; Ocean Thermal Energy; Geothermal Energy; Nuclear Energy; Hydro Energy. **(5 Lectures)**

Module – 2: Properties of pure substance, Boiler Mountings and Accessories: Definition; Function; Classification; Fire Tube and Water Tube Boilers; Cochran Boiler; Lancashire Boiler; Locomotive Boiler; Backcock and Wilcox Boiler; Packaged Boilers; High Pressure Boilers. Boiler Mountings & accessories. **(5 Lectures)**

Module – 3 Internal Combustion Engines: Classification of I.C. Engines, Petrol engine; Diesel engine; Gas Engine, Two- stroke & Four- stroke engine, C.I. Engines and S.I. Engines. **(5 Lectures)**

Module 4: Heat transfer; various modes of heat transfer, one dimensional steady state conduction. Application to composite walls and cylinders **(5 Lectures)**

Module 5: Simple stresses and strains, Hooke's Law elasticity, Relation between elastic constants, Thermal Stresses. **(5 Lectures)**

Module – 6 Transmission of Power: Transmission systems; Belt Drives; Flat belt; V-Belt; Limiting Tensions ratio, Chain drives; Gear Drives; Rope Drives; Types of gears; Gear Trains: Simple, compound and epicyclic gear trains. **(5 Lectures)**

Module 7: Vibrations, Types of Vibrations, Free undamped longitudinal vibrations, Free damped longitudinal vibrations. **(5 Lectures)**

Books:

1. Fundamentals of Classical Thermodynamics – G.J. Van Wylen and R.E. Sonntag, Second Edition, Wiley Eastern (1984).
2. An Introduction to Thermodynamics – P.K. Nag
3. Thermal Engineering – R.K. Rajput
4. Strength of Materials – F.L. Singer
5. Theory of Machines – Thomas Beven

Course code: ME 101

Course title: Basics of Mechanical Engineering

Pre-requisite(s):

Co- requisite(s):

Credits: 4 L: 3, T: 1, P: 0

Class schedule per week: 04

Class: B. Tech

Semester / Level: I/First

Branch: All

Name of Teacher:

Course Objectives

This course enables the students:

| | |
|----|---|
| 1. | To introduce system of forces, and write equation of equilibrium. |
| 2. | To analyse motion of particle and rigid body subjected to force. |
| 3. | To grasp the importance of internal, external combustion engines and heat transfer. |
| 4. | To apprehend the fundamentals of friction and vibration. |
| 5. | To understand the different sources of energy. |

Course Outcomes

After the completion of this course, students will be able to:

| | |
|-----|--|
| CO1 | Write and solve the equations of equilibrium for particles and structures members subjected to forces. |
| CO2 | Write and solve the equations of motion for particles and rigid bodies subjected to forces. |
| CO3 | Discuss the basics of Boilers, IC Engines and heat transfer. |
| CO4 | Aware of different types of vibrations and friction. |
| CO5 | Outline the non-conventional energy resources. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

(ME 101) Basics of Mechanical Engineering

Syllabus

Module 1: System of Forces and Structure Mechanics

Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Trusses, Plane and Space Trusses. Analysis of Plane Trusses by: Method of Joints and Method of Sections, Analysis of Frames with Hinged Joints. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants, Thermal Stresses, Properties of surfaces such as centroid and area moment of inertia. (9 L)

Module 2: Kinematics & Kinetics of rigid bodies

Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of translational and rotational motion, Newton's law and D'Alembert's principle –inertia force and inertia couple. (9 L)

Module 3: Friction and Vibration

Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction.(b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives.

Vibrations: Types of vibration, free un-damped longitudinal vibrations, free damped longitudinal vibrations. (9 L)

Module 4: Boilers and Internal Combustion Engine:

Boiler Mountings and Accessories, Fire Tube and Water Tube Boilers, Cochran Boiler, Babcock and Wilcox Boiler.

Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines.

Heat transfer: various modes of heat transfer, one dimensional steady state conduction, Application to composite walls and cylinder. (9 L)

Module 5: Non-Conventional Energy and their resources:

Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion, Solar Energy, Wind Energy, Tidal Energy, Ocean Thermal Energy; Geothermal Energy, Nuclear Energy, Hydro Energy. (9 L)


Prof. R. D. Das
Director
MESRA, RANCHI-835215

Text Books

1. Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.
2. Engineering Mechanics, S. Timoshenko, D. H. Young, J. V. Rao, Sukumar Pati, McGraw Hill education, 2017.
3. Theory of vibrations with applications, Thomson and Dahleh, Pearson Education, 5th Edition, 2008.
4. Boiler operator, Wayne Smith, LSA Publishers, 2013.
5. Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications, 2014.
6. Heat Transfer, J. P. Holman, Souvik Bhattacharya, Mcgraw Higher Ed Publishers, 2011.
7. Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication, 2012.

Reference Books

1. Engineering Mechanics : statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.
2. Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishing house, 2018.
3. Engineering Vibration, Daniel J. Inman, Pearson, 2013.
4. An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.
5. Internal Combustion Engines – V Ganesan, McGraw hill, 2017.
6. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel, Afshin J. Ghajar, McGraw Hill Education Publisher, 2017.
7. Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.
8. Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016.



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

**DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI
Courses of Studies for M.E. Programme in Heat Power**

| | L | T | P | C |
|---|----------------|----------|----------|--------------|
| I Semester: | | | | |
| (Theory Courses) | | | | |
| MME 1001 Advanced Fluid Mechanics | 3.0 | - | - | 3.0 |
| MME 1003 Heat and Mass Transfer | 3.0 | - | - | 3.0 |
| MMA 1103 Advanced Mathematics | 3.0 | 1.0 | - | 4.0 |
| Elective - any one | | | | |
| MME 1005 Turbomachines | 3.0 | - | - | 3.0 |
| MME 1009 Computational Methods in Thermal Engineering | | | | |
| MME 1013 Design of Thermal System | | | | |
| MME 1011 Theory and Design of I.C. Engines | | | | |
| Breadth Subject any one | 3.0 | - | - | 3.0 |
| Sessional: | | | | |
| MME 1002 Fluid Mechanics Laboratory | - | - | 3.0 | 2.0 |
| MME 1004 Elective Course Work | - | - | 3.0 | 2.0 |
| | Total | | | 20.00 |
| II Semester: | | | | |
| (Theory Courses) | | | | |
| MME 2001 Advanced Thermodynamics | 3.0 | - | - | 3.0 |
| MME 2013 Refrigeration and Air Conditioning | 3.0 | - | 1.0 | 4.0 |
| MME 2011 Gas Turbine and Jet Propulsion | 3.0 | - | - | 3.0 |
| Advanced Engineering Science | | | | |
| MME 2005 Fuels and Combustion | 3.0 | - | - | 3.0 |
| Breadth Subject: any one | | | | |
| | 3.0 | - | - | 3.0 |
| Sessional | | | | |
| MME 2002 Solar Energy Laboratory | - | - | 3.0 | 2.0 |
| MME 2004 Heat Transfer Laboratory | - | - | 3.0 | 2.0 |
| | Total : | | | 20.0 |
| III Semester: | | | | |
| 1. Thesis | | | | 15.0 |
| IV Semester: | | | | |
| 1. Thesis | | | | 20.0 |
| Grand Total | | | | 75.00 |

MME 1001: ADVANCED FLUID MECHANICS

MODULE- I

Description of fluid motion: Euler and Lagrangian description. Reynold's Transport theorem, rate of linear and angular strain, Mass, momentum and energy equations, Stream function and velocity potential function and its application. (5L)

MODULE-II

Navier-Stokes Equation: Derivation of Navier-Stokes equation, Exact solution of Navier-Stokes equations: Hagen-Poiseuille flow and Couette flow, Flow between two rotating cylinders. Stokes first and second problem. (5L)

MODULE-III

Boundary Layer: Blasius equation, Momentum integral and similarity techniques, Solution of boundary layer equations. Introduction to turbulent flow, Physical description of instabilities and turbulence, Reynold's averaging of N-S equation, Turbulent Boundary Layer over a flat plate. (5L)

MODULE-IV

Compressible flow: Review of fundamentals, One dimensional isotropic flow, Normal Shock relations, Stationary and moving shock waves, One dimensional diffusers. (5L)

Module-V

Oblique shock relations, Rankine-Hugoniot and Prandtl's equations. Working formulae, shock geometry, Shock polar diagram. (5L)

MODULE-VI

Flow in constant area duct with friction, Performance of long ducts and variation of pressure ratios, Chocking effects. Flow in duct with heating and cooling. (5L)

MODULE-VII

Two-dimensional subsonic flow with small perturbations, Linearization of the potential equation, Similarity laws. Hydrograph method for two-dimensional subsonic flow. (5L)

Books:

1. Fluid Mechanics by F.M. White.
2. Boundary Layer Theory by H. Schlichting.
3. Dynamics and Thermodynamics of Compressible flow by A.H. Shapiro.
4. Introductory Gas Dynamics by A.J. Chapman and W.F. Walker.
5. Fundamentals of Compressible flow by S.M. Yahya.

MME 1003 HEAT AND MASS TRANSFER

MODULE-I

Steady State Multidimensional Heat Conduction: Analytical, Graphical and numerical methods for solving heat transfer problems. (5L)

MODULE-II

Unsteady State Heat Conduction: Transient heat flow in a semi-infinite solid, sudden temperature change of the surface of a finite thick slab, unsteady state heat flow through semi infinite slab without surface resistance, multi dimensional transient heat flow system, Heisler charts for solving unsteady state problems, periodic heat flow. (5L)

MODULE-III

Equations of Convective Heat Transfer: Continuity and Navier-Stokes Equation, Energy Equation, similarity in convective heat transfer, vorticity and temperature fields, Equations for turbulent convective heat transfer, Boundary layer equations for laminar flow, Boundary layer equations for turbulent flow, boundary layer integral equation. (5L)

MODULE-IV

External Laminar Forced Convection: similarity and integral solutions of flow over isothermal and non-isothermal flat plate, Numerical solution of the laminar boundary layer flow over a flat plate and viscous dissipation effects on flow over a flat plate. (5L)

MODULE-V

Introduction to Turbulent Flows: governing equations, mixing length turbulence models, analogy solutions for heat transfer in turbulent flows, near walls region, transition from laminar to turbulent flow, analogy solution for boundary layer flows, numerical solution of turbulent boundary layer equations, viscous dissipation effects on turbulent boundary layer flow over a flat plate. (5L)

MODULE-VI

Radiation Heat Transfer: Shape factors of complicated geometries, use of graphs for finding shape factors, radiation between three gray bodies, radiation between gray cavity, radiation between hot gases and its enclosure, concept of radiation heat transfer coefficient, error calculation in the measurement of hot gas temperature, radiation through gases and vapours, radiation from flames. (5L)

MODULE-VII

Mass Transfer: Fick's law of diffusion; General equation of mass diffusion, mass transfer coefficient; convective mass transfer, mass transfer through boundary layer, analogy between momentum, heat and mass transfer; dimensional analysis of convective mass transfer. (5L)

Books:

1. Principles of Heat Transfer by Frank Kreith and Mark S. Bohn
2. Analytical Methods in Conduction Heat Transfer by Glen E. Meyers
3. Basic Heat and Mass Transfer by A. F. Mills.
4. Heat and Mass Transfer by J.P. Holman
5. A Text Book on Heat Transfer by S. P. Sukhatme

MME 1005: TURBOMACHINES

MODULE- I

Fundamental principles of turbomachines: Eulers equation, application to centrifugal machines, Axial flow pumps and turbines, Compressible flow theory, Shock wave effects, Cavitation, Illustrative examples of radial outflow machines, Axial pump and turbines, Example of a NPSE calculation. (5L)

MODULE-II

Centrifugal fan and blowers: Types, Centrifugal fan stage and design parameters, Drum and partial flow type fans, Losses, Fan bearings, Drives, Noise, Dust erosion of fans. (5L)

MODULE-III

Flow through cascades: Two-dimensional flow, Cascade of blades, Cascade tunnel, Axial turbine and compressor cascades, Annular and radial cascades. (5L)

MODULE-IV

Axial fans and propellers: Axial fans, Fan stage parameters, Types of axial fan stages, Propellers, Performance of axial fans. (5L)

Module-V

Three Dimensional flows in axial turbomachines: Theory of radial equilibrium, Compressible flow through fixed blade row, Constant specific mass flow, Off-design performance of a stage, Free vortex turbine stage, Actuator disc approach, Blade row interaction effects, Secondary flow. (5L)

MODULE-VI

Losses and Efficiency : Boundary layer losses, Flow separation, clearance and leakage losses, Windage losses, Partial admission losses, Secondary flow losses, Volumetric, Mechanical, hydraulic, Manometric and overall efficiencies, Diffuser, Nozzle and Blade efficiency; Mollier diagram for expansion and compression processes in turbine, compressor, Diffuser and nozzle; Total-to-total and Total-to-static efficiency, Polytropic efficiency, Cavitation, Stall, Surge and choking. (5L)

MODULE-VII

Dimension Analysis and Machine Performance : Dimensional analysis for incompressible and compressible flow turbomachines; Work-head and power coefficients; Mach number, Reynold's Number, Specific Speed and Cavitation parameter, Overall characteristics curves for pump, fan, Compressor and turbine, Similarity concept, Model study and scale effects. (5L)

Books:

1. Turbines Compressors and Fans by S. M. Yahya
2. Fluid Mechanics and Thermodynamics of Turbomachinery by S. L. Dixon
3. Turbomachines by V. KLadambi and Manohar Prasad.
4. Principles of Turbomachines by Turton.
5. Principles of Turbomachinery by D. G. Shepherd.

MME 1009: COMPUTATIONAL METHODS IN THERMAL ENGINEERING

MODULE- I

Overview of problems in thermal engineering, Backward , Forward and central differences, Interpolation formulas, Fourth order RK methods. (5L)

MODULE-II

Predictor-corrector methods and Nachsheim-Swigert iteration with application to tapered fin and other types of fin. (5L)

MODULE-III

Flow and heat transfer from flat plate and wedge (5L)

MODULE-IV

Stagnation point flow, Rotating disk and free convection from vertical flat plate. (5L)

Module-V

Round off error, Truncation error, Stability and convergence of algorithms. (5L)

MODULE-VI

Unsteady heat conduction equation and Laplace equation. (5L)

MODULE-VII

Keller box and Smith's method with applications to thermal boundary layers. (5L)

Books:

1. The CRC handbook of Thermal Engineering by Frank Kreith.
2. Computational methods in Environmental fluids by Olaf Kolditz.

MME 1013: DESIGN OF THERMAL SYSTEM

MODULE- I

Basic considerations in design: Formulation of the design problem, Conceptual design, Steps in the design process, Physical system, Modeling, Simulation, Evaluation, Optimal design, Computer aided design of thermal system. (5L)

MODULE-II

Modelling of thermal systems: Introduction, Types of models, Mathematical modelling, Modeling and similitude, Numerical modeling, System simulation, Flow of information, Synthesis of different design steps, Design of systems from different application areas(cooling of electronic equipments, heat transfer equipment). (5L)

MODULE-III

Problem formulation for optimization: Introduction, Objective function, Constraints, Optimization methods, Calculus methods, Search methods, Linear and dynamic programming, Geometric programming, Choice of variables for optimization, Sensitivity analysis, Multi-objective optimization. (5L)

MODULE-IV

Lagrange multipliers method, Significance of the multipliers, Optimization of unconstrained problems, Conversion of constrained to unconstrained problem, Optimization of constrained problems, Applicability to thermal systems. (5L)

Module-V

Search methods: Unconstrained search with multiple variables, Lattice search, Univariate search, Steepest ascent/descent method, Multivariable constrained optimization, Penalty function method, Search along a constraint, Examples of thermal system. (5L)

MODULE-VI

Geometric programming: Mathematical proof, Constrained optimization, Non zero degree of difficulty, Linear and dynamic programming. (5L)

MODULE-VII

Knowledge based design considerations: Introduction, Basic components, Expert knowledge, Design methodology, Application to thermal system. (5L)

Books:

1. Design and Optimization of Thermal System by Yogesh Jaluria
2. Design of Thermal System by Wilbert Stoecker.

MME 1011: THEORY AND DESIGN OF I.C. ENGINES

MODULE-I

Performance Parameters and Characteristics: Indicated and brake mean effective pressure, IP & BP, air standard, indicated and brake thermal, mechanical, relative, volumetric, scavenging, charge and combustion efficiencies, Performance characteristics and variables affecting the performance characteristics, Methods of improving Engine performance, Performance maps. (5L)

MODULE-II

Alternate Fuels: Solid, Liquid and gaseous fuels, Liquid fuels- Alcohol, methanol, ethanol, reformulated gasoline, water gasoline mixture, Gaseous fuels- Hydrogen, natural gas, CNG, LPG, their advantages and disadvantages, Biogas, dual fuel operation. (5L)

MODULE-III

Air Capacity of Four-Stroke Engines and Supercharging: Ideal air capacity, volumetric efficiency, effect of engine variables on volumetric efficiency, supercharging for S.I. and C.I. engines, types of superchargers and their characteristics, exhaust supercharging, performance of supercharged engines. (5L)

MODULE-IV

Electronic Fuel Injection systems: EFI system-merits and demerits, Multi-Point Fuel Injection (MPFI) system, Electronic Diesel Injection System, CRDI system. (5L)

MODULE-V

Engine Emissions and their control: Air pollution due to IC engines, Exhaust and non-exhaust emissions, HC,CO and NO_x emissions and their causes, Photochemical smog, Particulates, Aldehyde, sulphur, lead, phosphorous emissions, Emission control methods. (5L)

MODULE-VI

Engine Design: General design: types of cycle, number of cylinder and arrangements, compression ratio, speed, stroke-bore ratio, displacement, combustion chamber shape. Design of Principal Parts: cylinder, cylinder head, Crank case, pistons connecting rod, crank shaft, valves inlet and exhaust manifolds. (5L)

MODULE-VII

Design of Cooling System: Engine cooling arrangements, basic heat transfer equation, estimation of heat loss, radiator and fin design. (5L)

Books:

1. Internal Combustion Engines by E.F. Obert
2. Internal Combustion Engines by C.F. Taylor and Taylor
3. Internal Combustion Engines by M.L. Maleev
4. Diesel Engine Design by H.F.P. Purdey.

MME 2001: ADVANCED THERMODYNAMICS

MODULE-I

Recapitulation of fundamentals: Basic definitions and concepts, laws of thermodynamics, entropy flow and entropy production, third law of Thermodynamics. (5L)

MODULE-II

Availability in steady flow open system and in a closed system; Exergy analysis of typical thermal systems, Irreversibility and effectiveness. (5L)

MODULE-III

Properties and Pure substance: P-V-T surface, phase diagrams, phase changes, various property diagrams. First order phase transition and Clapeyron's equation, second order phase transition and Ehrenfest's equations, Maxwell's equations: equations for internal energy, enthalpy, entropy, specific heat, and Joule-Thomson coefficient. (5L)

MODULE-IV

Equation of state for real gases: Compressibility factor and generalized compressibility chart, law of corresponding states, Pseudocritical pressure and temperature, reduced co-ordinates, Vander Wall's equation of state, and other equations of state. (5L)

MODULE-V

Basic concepts of Irreversible Thermodynamics: Onsagar theory, derivation of Onsagar equations, Onsagar Reciprocal Relations, Fluctuation theory, Regression of fluctuations. (5L)

MODULE-VI

Chemical Thermodynamics: Gibb's theorem, Gibb's function of mixture of inert ideal gases. Chemical equilibrium, Thermodynamics equation for phase, degree of Reaction, equation of reaction equilibrium, Law of Mass Action, Heat of Reaction and Vant hoff Isobar, Saha's equation for standard Gibb's function change, affinity. (5L)

MODULE-VII

Statistical Thermodynamics: Importance of statistical analysis, Stirling's approximation, Bose-Einstein statistics and Fermi-Dirac statistics, classical Maxwell-Boltzman model, equilibrium distribution, microscopic interpretation of heat and work, entropy, second law of thermodynamics, partition function and its properties. (5L)

Books:

1. Concept of Thermodynamics by O.R. Obert
2. Heat and Thermodynamics by M. Zemansky
3. Thermodynamics by G.J. VanWylen
4. Thermodynamics by Holman.

MME-2013 REFRIGERATION AND AIR CONDITIONING

MODULE-I

Cooling and Heating Load Calculations - I: Estimation of Solar Radiation : Introduction to cooling and heating load calculations, Solar radiation, Solar geometry, Calculation of direct, diffuse and reflected radiation using ASHRAE solar radiation model, Effect of clouds. (5L)

MODULE-II

Cooling and Heating Load Calculations –II :Solar Radiation Through Fenestration Ventilation And Infiltration Need for fenestration in buildings and effects of fenestration on air conditioning systems, concepts of Solar Heat Gain Factor (SHGF) and Shading Coefficient, calculation of shaded area of fenestrations, Need for ventilation and recommended ventilation rates, Infiltration and causes for infiltration, Estimation of heat transfer rate due to infiltration and ventilation. (5L)

MODULE-III

Cooling and Heating Load Calculations - III:

Heat Transfer Through Buildings - Fabric Heat Gain/Loss General aspects of heat transfer through buildings, one-dimensional, steady state heat transfer through homogeneous, non-homogeneous walls, opaque walls and roofs with suitable initial and boundary conditions, semi-empirical methods based on Effective Temperature Difference or Cooling Load Temperature Difference, discuss the physical significance of decrement and time lag factors and present typical tables of CLTD for walls and roof. (5L)

MODULE-IV

Selection of Air Conditioning Systems: Introduction to thermal distribution systems and their functions, Selection criteria for air conditioning systems, Classification of air conditioning systems, Working principle, advantages, disadvantages and applications of all air systems, e.g. single duct, constant volume, and single/multiple zone system, single duct, dual duct, constant & variable air volume (VAV) systems, outdoor air control in all air systems, advantages/disadvantages & applications of all air systems, working principle, advantages, disadvantages and applications of all water systems, air-water systems, working principle, advantages, disadvantages and applications of unitary refrigerant based systems. (5L)

MODULE-V

Transmission of Air in Air Conditioning Ducts: Air Handling Unit (AHU) and its functions, need for transmission aspects of air in air conditioning, airflow through air conditioning ducts, Bernoulli and modified Bernoulli equations, Static, dynamic, datum and total head, Fan Total Pressure (FTP) and power input to fan, estimation of pressure loss through air conditioning ducts,, Estimation of frictional pressure drop of circular and rectangular ducts using friction charts and equations, Estimation of dynamic pressure drop in various types of fittings, Static regain. (5L)

MODULE-VI

Design of Air Conditioning Ducts: Important requirements of an air conditioning duct, General rules for duct design, Classification of duct systems, Commonly used duct design methods, Principle of velocity method, Principle of equal friction method, Principle of static regain method, Performance of duct systems, System balancing and optimization, Introduction to fans and fan laws, Interaction between fan and duct systems. (5L)

MODULE-VII

Ventilation for Cooling Use of ventilated air for cooling of buildings and cooling of occupants, comparison between natural ventilation and mechanical ventilation, characteristics of natural ventilation and estimation of airflow rate due to wind and stack effects, general guidelines for natural ventilation and forced ventilation using electric fans, interior air movement using interior fans, unit ventilators, whole house fans and solar chimneys. (5L)

Books:

1. Refrigeration and Air Conditioning by Stoker W. F.
2. Refrigeration and Air Conditioning by C. P. Arora, Tata McGraw-Hill
3. Refrigeration and Air Conditioning by Ahmadul Ameen, PHI Publication
4. Hand Book of Air conditioning and Refrigeration by Shan k. Wang, Tata McGraw-Hill

MME 2011: GAS TURBINE AND JET PROPULSION

MODULE- I

Gas turbine system and cycles: Principles of gas turbine systems, Ideal cycle analysis, Performance of practical gas turbine cycles, Effect of varying mass flow, Effect of variable specific heat, Mechanical losses, Loss due to incomplete combustion, Polytropic efficiency. (5L)

MODULE-II

Centrifugal compressors: Principle of operation, Work-done and pressure rise, Diffuser, compressibility effects, Non-dimensional quantities for plotting compressor characteristics, Compressor characteristics. (5L)

MODULE-III

Axial flow compressors: Basic operation, Elementary theory, Factor effecting stage pressure ratio, Blockage in the compressor annulus, Degree of reaction, Three dimensional flow, Design process, Blade design, Calculation of stage performance, Compressibility effects, Axial compressor characteristics. (5L)

MODULE-IV

Axial and radial flow turbines: Elementary theory of axial flow turbine, Vortex theory, Choice of blade profile, Pitch and chord, Estimation of stage performance, Overall turbine performance, the cooled turbine, Radial flow turbine. (5L)

Module-V

Combustion systems: Operational requirement, Types of combustion system, Some important factors effecting combustor design, the combustion processes, Combustion chamber performance, Mixing and dilution, Combustion chamber arrangement. (5L)

MODULE-VI

Jet propulsion cycles and their analysis: Introduction, the Ramjet, Pulsejet, Turbojet, Turboprop, Thrust and thrust equations, Specific thrust of the turbojet engine, Efficiencies, Parameters effecting flight performance and thrust argumentation. (5L)

MODULE-VII

Rocket propulsion: Principle of rocket propulsion, Analysis of an ideal chemical rocket, Optimum expansion ratio for rocket, the chemical rocket, Advantages of liquid propellant rockets over solid propellant rockets, Free radial propulsion, Nuclear propulsion, Photon propulsion. (5L)

Books:

1. Gas turbine theory by Cohen and Rogers
2. Gas turbines by V. Ganesan

MME 2005: FUELS AND COMBUSTION

MODULE I

Conventional Solid, liquid and gaseous fuels, Manufacture and uses of Producer gas and water gas. (5L)

MODULE II

Substitute fuels and miscellaneous synthetic fuels. (5L)

MODULE III

Chemical equation of combustion and conservation of mass, Enthalpy of formation, Enthalpy and Internal Energy of Combustion, Adiabatic Flame Temperature. Equilibrium and dissociation, reversible chemical reaction and equilibrium constant. (5L)

MODULE IV

Chemical Kinetics: rate and order of reaction, First and Second order reactions. (5L)

MODULE V

Molecular Kinetics: Molecular and order, Theories of Collision. (5L)

MODULE VI

Flames and Combustion, flame propagation, Quenching and Ignition, Flammability – Theories of flame propagation. Diffusion Flame: Combustion of solid, Liquid particles packed beds and gaseous jets. (5L)

MODULE VII

Flame Stabilization: Unstable flames, Solid carbon in flames. Atomization, vapourization and mixing, Engineering implications of combustion studies: Design methods. (5L)

Books:

1. Chemical Kinetic – M. L. Smith and K. W. Steenson
2. Chemistry – M.J. Sienko and M.J. Plane
3. Flame and Combustion – J.N. Radley
4. Alternative Energy Sources – Nejat Veziroglu

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for all M.Tech in Heat Power Engineering

| SEMESTER / Session of Study (Recommended) | Course Level | Category of course | Course Code | Courses | Mode of delivery & credits L-Lecture; T-Tutorial;P- Practicals | | | Total Credits C- Credits |
|---|-----------------|---|-------------|---|--|-------------------------|-------------------------|--------------------------------|
| | | | | | L (Periods/ week) | T (Periods/ week) | P (Periods/ week) | C |
| FIRST / Monsoon | FIFTH | THEORY | | | | | | |
| | | Programme Core (PC) | ME561 | Classical and Statistical Thermodynamics | 3 | 1 | 0 | 4 |
| | | | ME562 | Advanced Incompressible Fluid Flow | 3 | 1 | 0 | 4 |
| | | | ME563 | Conduction and Radiation Heat Transfer | 3 | 0 | 0 | 3 |
| | | Programme Elective (PE)*(* Student can choose only one of these) | ME564 | Renewable Source of Energy | 3 | 0 | 0 | 3 |
| | | | ME565 | Theory and Design of I.C. Engines | 3 | 0 | 0 | 3 |
| | | | ME566 | Computational Methods in Thermal Engineering | 3 | 0 | 0 | 3 |
| | | | ME567 | Safety Aspects of Nuclear Power Plants | 3 | 0 | 0 | 3 |
| | | Open elective OE | | Open Elective (OE) 1 | 3 | 0 | 0 | 3 |
| | | LABORATORIES | | | | | | |
| | | Programme Core (PC) | ME568 | Advanced Fluid Mechanics Lab | 0 | 0 | 4 | 2 |
| TOTAL | | | | | | | 19 | |
| SECOND/ Spring | FIFTH | THEORY | | | | | | |
| | | Programme Core (PC) | ME571 | Convective Heat and Mass Transfer | 3 | 0 | 0 | 3 |
| | | | ME572 | Modern Power Plant Engineering | 3 | 0 | 0 | 3 |
| | | | ME573 | Design of Thermal Systems | 3 | 0 | 0 | 3 |
| | | Programme Elective (PE)*(* Student can choose only one of these) | ME574 | Advanced Turbo-Machines | 3 | 0 | 0 | 3 |
| | | | ME575 | Computational Fluid Dynamics | 3 | 0 | 0 | 3 |
| | | | ME576 | Advanced Energy Technology | 3 | 0 | 0 | 3 |
| | | OPEN ELECTIVE OE | | (OE) SUBJECT 2 | 3 | 0 | 0 | 3 |
| | | LABORATORIES | | | | | | |
| | | Programme Core (PC) | ME577 | Advanced Heat Transfer Lab | 0 | 0 | 4 | 2 |
| | | | ME578 | CFD Lab | 0 | 0 | 4 | 2 |
| TOTAL | | | | | | | 19 | |
| TOTAL FOR FIFTH LEVEL | | | | | | | 38 | |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215


| | | THEORY | | | | | | |
|--|------------------------|---|-------------------------|--|---|---|----|----|
| THIRD / Monsoon | SIXTH | Programme Core (PC) | ME600 | Thesis Part I | | | | 8 |
| | | | ME642 | Advanced Refrigeration & Air Conditioning | 3 | 0 | 0 | 3 |
| | | Programme Elective (PE)*(* Student can choose only one of these) | ME643 | Dynamics of Compressible Fluid Flow | 3 | 0 | 0 | 3 |
| | | | ME644 | Design and Analysis of Heat Exchangers | 3 | 0 | 0 | 3 |
| | | | ME645 | Steam Engineering | 3 | 0 | 0 | 3 |
| | LABORATORIES | | | | | | | |
| | Programme Core (PC) | ME646 | Thermal Engineering Lab | 0 | 0 | 4 | 2 | |
| TOTAL | | | | | | | 16 | |
| FOURTH/ Spring | SIXTH | THEORY | | | | | | |
| | | Programme Core (PC) | ME650 | Thesis Part II | | | | 16 |
| | TOTAL | | | | | | | 16 |
| TOTAL FOR SIXTH LEVEL | | | | | | | 32 | |
| GRAND TOTAL FOR M.TECH PROGRAMME (38 + 32) | | | | | | | 70 | |


Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

DEPARTMENT OF MECHANICAL ENGINEERING
PROGRAMME ELECTIVES (PE) Mtech in Heat Power Engineering
OFFERED FOR LEVEL 5-6

| PE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|------------|----------|--|---------------------------------|---|---|---|---|
| 5 | ME 564 | Renewable Source of Energy | NIL | 3 | 0 | 0 | 3 |
| | ME 565 | Theory and Design of I.C. Engines | NIL | 3 | 0 | 0 | 3 |
| | ME 566 | Computational Methods in Thermal Engineering | NIL | 3 | 0 | 0 | 3 |
| | ME 567 | Safety Aspects of Nuclear Power Plant | NIL | 3 | 0 | 0 | 3 |
| | ME 574 | Advanced Turbo-Machines | NIL | 3 | 0 | 0 | 3 |
| | ME 575 | Computational Fluid Dynamics | ME 562 | 3 | 0 | 0 | 3 |
| | ME 576 | Advanced Energy Technology | NIL | 3 | 0 | 0 | 3 |
| 6 | ME 643 | Dynamics of Compressible Fluid Flow | ME 562 | 3 | 0 | 0 | 3 |
| | ME 644 | Design and Analysis of Heat Exchangers | NIL | 3 | 0 | 0 | 3 |
| | ME 645 | Steam Engineering | NIL | 3 | 0 | 0 | 3 |

*** PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS**


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

**DEPARTMENT OF MECHANICAL ENGINEERING
OPEN ELECTIVES (OE)*
OFFERED FOR LEVEL 5-6**

| OE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|------------|----------|------------------------------|---------------------------------|---|---|---|---|
| 5 | ME582 | Design Methodology | NIL | 3 | 0 | 0 | 3 |
| | ME583 | Renewable Source of Energy | NIL | 3 | 0 | 0 | 3 |
| | ME584 | Energy Management & Auditing | NIL | 3 | 0 | 0 | 3 |
| | ME585 | Industrial Robotics | NIL | 3 | 0 | 0 | 3 |
| | ME586 | Reliability in Design | NIL | 3 | 0 | 0 | 3 |

*** OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS**


**Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215**

Programme Educational Objectives (PEOs) – Heat Power Engineering

PEO 1: To develop capability to understand the fundamentals of Science and Heat Power Engineering for analyzing the engineering problems with futuristic approach.

PEO 2: To foster a confident and competent post graduate capable to solve real life practical engineering problems fulfilling the obligation towards society.

PEO 3: To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.

PEO 4: To nurture and nourish effective communication and interpersonal skill to work in a team with a sense of ethics and moral responsibility for achieving goal.

PROGRAM OUTCOMES (POs)

M. Tech. in Mechanical Engineering (Heat Power Engineering)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Clear insight to appreciate the multidisciplinary nature of the technological field in heat power engineering.

PO5: Develop an ability to work in team, apart from having awareness of social needs and professional code of conduct, ethics and behavior.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME561

Course title: Classical and Statistical Thermodynamics

Pre-requisite(s): B.E. /B. Tech. Thermodynamics

Co- requisite(s): Partial Differential Equations

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:


This course enables the students to:

| | |
|----|---|
| 1. | Present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as heat transfer and energy conversion systems and to prepare the students to effectively use thermodynamics in the practice of engineering. |
| 3. | Develop an intuitive understanding of thermodynamics by emphasizing the engineering and engineering arguments. |
| 4. | Present a wealth of real world engineering examples to give students a feel for how thermodynamics is applied in engineering practice. |

Course Outcomes:

At the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Review and Apply the concepts of I and II law of thermodynamics. |
| CO2 | Analyse and evaluate the concept of exergy in different thermodynamic cycles |
| CO3 | Analyze the concept of Real Gases and Mixtures and to apply the thermodynamic relations of gas mixtures. |
| CO4 | Evaluate the Thermodynamic properties of homogeneous mixtures. |
| CO5 | Analyze the concept of statistical thermodynamics. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Review of I and II Laws of Thermodynamics: Transient flow analysis, entropy balance for flow and non-flow systems, entropy generation, properties of pure substance, PVT surface, Third law of thermodynamics, Nerst heat theorem. (8L)

Module 2:

Exergy Analysis: Concepts, exergy balance analysis for flow, non-flow and transient systems, exergy transfer, exergetic/ Second Law efficiency, Second Law analysis of different thermal systems. (8L)

Module 3:

Real Gases and Mixtures: Equations of state- vander wall's equation of state and other equation of state, virial expansion, Law of corresponding state, compressibility factor, reduced coordinate system and generalized compressibility chart.

Thermodynamic Relationships: First order phase transition and Clapeyron's equation, second order phase transition and Ehrenfest's equations, Maxwell's equations: equations for internal energy, enthalpy, entropy, specific heat, and Joule-Thomson coefficient. (8L)

Module 4:


Chemical Thermodynamics: Gibb's theorem, Gibb's function of mixture of inert ideal gases. Chemical equilibrium, Thermodynamics equation for phase, degree of Reaction, equation of reaction equilibrium, Law of Mass Action, Heat of Reaction and Vant hoff Isobar, Saha's equation for standard Gibb's function change, affinity. (8L)

Module 5:

Statistical Thermodynamics: Importance of statistical analysis, Stirling's approximation, Bose-Einstein statistics and Fermi-Dirac statistics, classical Maxwell-Boltzman model, equilibrium distribution, microscopic interpretation of heat and work, entropy, second law of thermodynamics, partition function and its properties. (8L)

Text Books

1. P.K. Nag, Basic and Applied Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd., 2010.
2. Yonus A Cengel and Michale A Boles, Thermodynamics: An Engineering Approach, McGraw Hill, 2002.
3. A. Bejan, Advanced Engineering Thermodynamics, John Wiley & Sons, 2006.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME562

Course title: Advanced Incompressible Fluid Flow

Pre-requisite(s): B.E. /B. Tech. Fluid Mechanics

Co- requisite(s): Partial Differential Equation

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:

This course enables the students to:

| | |
|----|---|
| 1. | Present a comprehensive and rigorous treatment of classical incompressible fluid mechanics while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as analysis of various incompressible fluid flows and to prepare the students to effectively use incompressible fluid mechanics theory in the practice of engineering. |
| 3. | Develop an intuitive understanding of incompressible fluid mechanics by emphasizing the engineering and engineering arguments. |
| 4. | Present a wealth of real world engineering examples to give students a feel for how incompressible Fluid mechanics is applied in engineering practice. |

Course Outcomes:

At the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Outline the concepts of continuum, system of control volume, incompressible fluid and flow properties. |
| CO2 | Apply the appropriate fundamental laws of incompressible fluid dynamics to various flow passages and over the bodies. |
| CO3 | Analyse various incompressible fluid dynamics problems. |
| CO4 | Evaluate the applicability governing equations of incompressible fluid mechanics where an exact solution of the problem is possible. |
| CO5 | Create optimum design of simple(2D)/complex(3D) fluid flow geometry using conventional methods and modern tools. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Definition and properties of fluids, fluid as continuum, Lagrangian and Eulerian description of fluid flow, velocity and stress field, fluid statics, fluid kinematics. stream and velocity potential function, circulation, irrotational vortex.

Potential flows: Uniform stream, source and sink, vortex flow, doublet, superposition of basic plane potential flows, flow past a half body, flow past a Rankine Oval body, flow past a circular cylinder, concept of lift and drag. (8L)

Module 2:

Reynolds transport theorem, Integral and differential forms of governing equations, mass, momentum and energy conservation equations, Navier Stokes equations and its formulation, solution of Navier Stokes equations like Couette flow, Poiseuille flow, Hagen Poiseuille flow, flow between two concentric rotating cylinders, theory of Hydrodynamic lubrication, flow around a sphere, Stokes first and second problem. (8L)

Module 3:


Boundary layer equations, boundary layer thickness, boundary layer on a flat plate, similarity solutions, integral form of boundary layer equations, approximate methods, flow separation, developing flow in a duct. (8L)

Module 4:

Introduction to Hydrodynamic Stability, Why do instabilities occur ?, Concept of small-disturbance stability, Linear stability theory, Rayleigh–Taylor instability, Kelvin-Helmholtz instability, Orr-Sommerfeld and Squire equations, Squire's transformation and Squire's theorem, inviscid stability theory, capillary Instability of a Jet, asymmetric instability of a liquid jet, instability due to shear, stability of parallel shear flows, boundary layer stability, thermal instability, mechanics of boundary layer transition. (8L)

Module 5:

Characteristics of turbulent flow, general equations of turbulent flow, turbulent boundary layer equation, flat plate turbulent boundary layer, turbulent pipe flow, Prandtl mixing hypothesis. Turbulence modeling - Zero equation model: mixing length model, One equation model: Spalart-Almaras, Two equation models: k- ϵ models (standard, RNG, realizable), k- ω model, and ASM, Seven equation model: Reynolds stress model, free turbulent flows. Numerical examples. Basic concepts on flow simulation using softwares. (8L)


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME563

Course title: **Conduction and Radiation Heat Transfer**

Pre-requisite(s): B.E. /B. Tech. Heat Transfer

Co- requisite(s): Partial Differential Equations

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:


This course enables the students to:

| | |
|----|---|
| 1. | Present a comprehensive and rigorous treatment of conductive and radiative heat transfer while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as heat transfer systems and to prepare the students to effectively use of conductive and radiation heat transfer analysis in the practice of engineering. |
| 3. | Develop an intuitive understanding of conductive and radiative heat transfer by emphasizing the engineering and engineering arguments. |

Course Outcomes:

At the end of the course, a student should be able to:

| | |
|-----|---|
| CO1 | Identify modes of heat transfer and model basic heat transfer processes. |
| CO2 | Apply different methods for solution of multi-dimensional engineering problems of conductive heat transfer. |
| CO3 | Apply different methods for solution of radiative heat transfer problems in non-participating medium. |
| CO4 | Analyse gray and non-gray problems in the field radiative heat transfer in participating medium. |
| CO5 | Evaluate the solution for one dimensional gray medium. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Multidimensional conduction-I: Introduction, integral form of governing equation, differential form of governing equation, simplified form of energy equation, thermal diffusivity, one-dimensional transient conduction: transient in a semi-infinite solid, approximate integral method due to Goodman, one dimensional transient problem: space domain finite, steady conduction in two dimensions: steady conduction in rectangle, steady conduction in a rectangle with heat generation, steady two-dimensional conduction in cylindrical co-ordinates, shape factors for some useful configurations, solution to Laplace equation in cylinder, solution to a practical problem, solution to Laplace equation in spherical co-ordinates. (8L)

Module 2:

Multidimensional conduction-II: Introduction, basic problem in Cartesian coordinates, basic problem in cylindrical coordinates, basic problem in spherical co-ordinates, one term approximation and Heisler charts: one term approximation of the slab transient, one term approximation of the cylinder transient, one term approximation of the sphere transient, transient conduction in more than one dimension: Introduction, transient conduction in an infinitely long rectangular bar, transient heat conduction in a rectangular block in the form of a brick, transient heat conduction in a circular cylinder of finite length. (8L)

Module 3:

Thermal radiation: the physics of radiation, thermodynamics of black body radiation, Planck distribution, properties of the Planck distribution functions, shape factor of complicated geometry, use of graphs for finding shape factors, radiation irradiation method of enclosure analysis, Enclosure containing diffuse non-gray surfaces, gray enclosures containing diffuse and specular surfaces. (8L)

Module 4:

Radiation in participating media: Introduction, definitions, equation of transfer, absorption of radiation in different media: transmittance of a solid slab, absorption of radiation by liquids, absorption of radiation by gases, radiation in an isothermal gray gas slab and the concept of mean beam length, modeling of gas radiation: basics of gas radiation modeling, band models, radiation in a non-isothermal participating medium: radiation transfer in a gray slab, radiation equilibrium, solution of integral equation, enclosure analysis in the presence of an absorbing and emitting gas: zone method, example of zone analysis. (8L)

Module 5:

Exact solution for one-dimensional gray media: Introduction, general formulation for a plane parallel Medium, radiative equilibrium of a non-scattering medium, radiative equilibrium of a scattering medium, plane medium with specified temperature field, radiative transfer in spherical media, radiative transfer in cylindrical media, numerical solution of the governing integral equations. (8L)

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME564

Course title: Renewable Energy Technology

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:

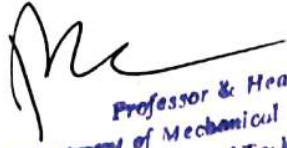
This course enables the students to:

| | |
|----|--|
| 1. | Identify renewable energy sources and their utilization. |
| 2. | Provide basic knowledge of different renewable energy conversion principle. |
| 3. | Harness the environment friendly RE sources and to enhance their contribution to the socio-economic development. |

Course Outcomes:

At the end of the course, a student should be able to:

| | |
|-----|---|
| CO1 | Outline the principles of energy conversion from solar energy sources. |
| CO2 | Understand the application of wind energy conversion system. |
| CO3 | Develop capability to do basic design of bio gas plant. |
| CO4 | Understand the applications of different renewable energy sources like ocean thermal, hydro, geothermal energy etc. |
| CO5 | Perform energy and exergy analysis of renewable energy systems. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system, Solar Cookers, Solar driers, Solar Still, Solar Furnaces, Solar Green Houses. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies. (8L)

Module 2:

Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram. (8L)

Module 3:


Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifiers, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass, Biomass programs in India. (8L)

Module 4:

Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation. Geothermal Energy: Introduction, Capacity and Potential, Resources of geothermal energy. (8L)

Module 5:

Energy and Exergy Analysis: Energy Matrices, Embodied Energy, Embodied Energy and Annual Output of Renewable Energy Technologies, Exergy Analysis, CO₂ Emissions, Earned Carbon Credit. (8L)


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
JBSRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME565

Course title: Theory and Design of I.C. Engines

Pre-requisite(s): B.E. /B. Tech. I.C. Engine

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:


This course enables the students to:

| | |
|----|---|
| 1. | Explore the knowledge of performance parameters and its characteristics, variables effects the performance of engine and methods of improving engine performance of internal combustion engine. |
| 2. | Examination and selection of different alternative fuel and its emissions and control. |
| 3. | Explore principle of different electronic fuel injection system, supercharging and its effect on performance of internal combustion engine. |
| 4. | Design and recommend low cost and high performance engine components, which finds applications in modern internal combustion engines. |

Course Outcomes:

At the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Explain performance parameters and characteristics; and calculation of performance parameters. |
| CO2 | Interpret different alternative fuels and its emissions, then the method to control these emissions. |
| CO3 | Analyze different electronic fuel injection system, supercharging and its effect on performance of SI and CI engine. |
| CO4 | Specify and interpret data of alternative fuels and its emission which effect the environment. |
| CO5 | Design low cost and high performance cylinder, cylinder head, crank case piston, connecting rod, crank shaft and radiator of Internal combustion engine. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Performance Parameters and Characteristics: Indicated and brake mean effective pressure, IP & BP, air standard, indicated and brake thermal, mechanical, relative, volumetric, scavenging, charge and combustion efficiencies, effect of spark timing, mixture composition, load, speed, and compression ratio on engine performance and efficiency. Performance characteristics and variables affecting the performance characteristics, Methods of improving Engine performance, Performance maps. (8L)

Module 2:

Alternate Fuels: Solid, Liquid and gaseous fuels, Liquid fuels- Alcohol, methanol, ethanol, reformulated gasoline, water gasoline mixture, Gaseous fuels- Hydrogen, natural gas, CNG, LPG, their advantages and disadvantages, Biogas, dual fuel operation. Emission from alternative fuels, status of alternative fuels in India. (8L)

Module 3:

Air Capacity of Four-Stroke Engines and Supercharging: Ideal air capacity, volumetric efficiency, effect of engine variables on volumetric efficiency, supercharging for S.I. and C.I. engines, types of superchargers and their characteristics, exhaust supercharging, performance of supercharged engines. Multi-Point Fuel Injection (MPFI) system, Electronic Diesel Injection System, CRDI system and its advantages and disadvantages. (8L)

Module 4:

Engine Emissions and their control: Air pollution due to IC engines, Exhaust and non-exhaust emissions, HC, CO and NO_x emissions and their causes, Photochemical smog, Particulates, Aldehyde, sulphur, lead, phosphorous emissions, Emission control methods. (8L)

Module 5:

Engine Design: General design concept of IC engine, design of principal parts of IC engine cylinder head, pistons, connecting rod, crank shaft, radiator and fan. (8L)

Text Books

1. Internal Combustion Engine, Ganesan, V., McGraw Higher Ed., 2012.
2. Internal Combustion Engines, Obert, E.F., International Textbook Co., 1968.
3. The Internal Combustion Engines in Theory and practice, Taylor, C.F., MIT Press, 1985.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835213

SYLLABUS

Module 1:

Root finding: Complex algebraic and transcendental equations. Solution of linear equations by LU decomposition and Newton Raphson method, Root finding used in integration, evaluation of areas, surface of revolution, length of curve and volumes. (8L)

Module 2:

Evaluation of centroid of regular geometric bodies, Double integration to compute areas, triple integration to compute volumes and quadruple integration to compute view factors, Interpolation and its use in thermal engineering. (8L)

Module 3:

Solution of ordinary differential equations, Runge-Kutta method and Euler method, Solution of non-linear equations of any order and any degree, Solution of initial value problems and boundary value problems, Solution of boundary value problem through initial value problems, shooting method, optimization of objective functions to determine the solution of boundary value problems. (8L)

Module 4:

Application of shooting method or the optimization method to solve thermal engineering problems like: boundary layer flow on a flat plate, thermal boundary layer on a vertical and flat plate, flow near a rotating disk, Falkner-Skan wedge flow, travel of projectile in air with drag, temperature distribution in a circular fin, triangular fin and general solution to steady 1D heat conduction in any shape. (8L)

Module 5:

Introduction to finite difference (FD) method, Forward, Backward, CD and upwind schemes, Solution of ODE by FD method, Introduction to stability, numerical errors and accuracy, Application of finite difference method to thermal engineering problems, Solution of hydrodynamic and thermal boundary layer equations by FD method, Solution of Falkner-Skan problem by FD method, Extensive Application to transient heat transfer by FD method. FD method used for 2D and 3D problems. Demonstration and use of software such as EES to apply different methods and solve system of equations (linear or nonlinear) mentioned above. (8L)

Text Books

1. Iyenger, Jain, Numerical Methods Numerical Methods for Scientific & Engineering Computation, New age international Pvt. Ltd., 2003.
2. Dennis Zill, Warren Wright, Advanced Engineering Mathematics, Jones and Bartlett Publishers, 2010.
3. K. E. Atkinson, An Introduction to Numerical Analysis, John Wiley & Sons, 1989.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME567

Course title: Safety Aspects of Nuclear Power Plants

Pre-requisite(s): B.E. /B. Tech. Energy conversion system

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives:

This course enables the students to:

| | |
|----|---|
| 1. | Familiarize the students on the future benefits of Nuclear power plants. |
| 2. | Develop an intuitive understanding of safety of Nuclear power plants |
| 3. | Study the regulatory approaches adopted, which assures the safety of NPP. |

Course Outcomes:

At the end of the course, a student should be able to:

| | |
|-----|---|
| CO1 | Outline the basic concept of Nuclear reactors. |
| CO2 | Analyse the various Radiation sources and Protection of NPP |
| CO3 | Analyze the safety principles. |
| CO4 | Evaluate and Analyze some events in NPP and Sitings of Nuclear plants |
| CO5 | Analyze the safety regulations in india. |



*Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835213*

SYLLABUS

Module 1:

Introduction: Energy sources, Nuclear Power Production, medical and Societal applications of radiation, Nuclear fuel cycle.

Basic Physics of Nuclear Reactors: Atomic Structure, isotopes, Radioactivity, half life, Basics of fission reaction, Moderation, Criticality, Decay heat, Reactivity and Feedback, Breeding. (8L)

Module 2:

Nuclear Reactor Types: Components of Nuclear Reactor, Present Reactor Types, Generation IV Concepts.

Radiation sources and Protection: Radiation and its units, Natural background and manmade Radiation, Biological Effects, Exposure limits and protection, Sources of radiation, shielding. (8L)

Module 3:

Safety Principles and approach: Safety objectives, Defence in depth philosophy, Multiple barriers, Rad-waste management, Levels of defence, Redundancy, Diversity Principles, Event analysis, core inventory, emergency response.

Deterministic approach- Design Basis Events & Beyond Design Basis Events, Acceptance Criteria, Probabilistic approach- Fault tree, event tree, failure rates.

Engineered Safety Systems: Shutdown systems in PWR, BWR,PHWR, Reactivity Worth of shutdown system, Trip Signals, Safety Logic, Operating Environment, Grouping of safety systems, Heat Removal systems, Emergency Core Cooling, Containment and subsystems. (8L)

Module 4:

Analysis of Some Events in NPP: Heat transfer and Fluid flow prediction, validation, Safety set points, Safety actions for events, Spurious opening of Pressuriser valve in a PWR, LOCA analysis Indian PHWR, Station Blackout without Reactor Trip, FBTR.

Siting of Nuclear plants: Site evaluation Stages, Site Rejection Criteria, Earthquake, Geological criteria, Meteorological considerations, Flooding, Tsunami, Shoreline erosion, chemical explosion, Radiological impact study, Radioactivity pathways to humans, environmental Impact study. (8L)

Module 5:

Safety Regulation In India: Atomic Energy Regulatory Board, functions, safety Documents, Safety Review of site, design, regulatory inspections, safety review for PFBR, Koodankulam, Regulatory review of operating plants, Licensing stages, licensing of operating personnel, Training simulator, safety up-gradation Review after TMI Chernobyl, Review after Fukushima, safety review for decommissioning, Safety Review of Radiation Facilities, medical X-ray units, Gamma irradiators. (8L)


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME568

Course title: Advanced Fluid Mechanics Lab

Pre-requisite(s): Fluid Mechanics

Co-requisite(s): Nil

Credits: 2 L: 0 T: 0 P:4

Class schedule per week: 04

Class: M. Tech

Semester/Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Be familiar with various types fluid flow measurement systems. |
| 2. | Be confident on how to perform experiments related Fluid mechanics, different measurement systems. |
| 3. | Study in detail the flow field around and through complex passages to enable students to calculate the characteristics of those systems. |

Course Outcomes

After the completion of this course, a student should be able to:

| | |
|-----|---|
| CO1 | Understand the procedure to conduct experiments related to fluid mechanics devices and components using different measurement systems and equipments. |
| CO2 | Interpret various parameters influence the performance of the fluid mechanics devices and components. |
| CO3 | Analyze the observations made through experiments. |
| CO4 | Apply the experimental knowledge how to perform the experiments in different manner. |
| CO5 | Predicting the sources of errors and minimizing them in the experiments. |

List of experiments:

Experiment 1: Performance study on calibration of a wind tunnel.

Experiment 2: Performance study on flow field behind a circular cylinder using wind tunnel.

Experiment 3: Performance study on flow field behind a square cylinder using wind tunnel.

Experiment 4: Performance study on effect of circular cylinder in tandem on the flow field behind the rear cylinder using wind tunnel.

Experiment 5: Flow visualization using woollen turf to find out the position of point of separation on a circular cylinder.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Experiment 6: Performance study on calibration the pressure sensors used in pressure transducer.

Experiment 7: Performance study on pressure distribution at different location on a conical/circular body.

Experiment 8: Schlieren and shadowgraph flow visualization at supersonic speed.

Experiment 9: Flow visualization over a cylinder using water tunnel.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME571

Course title: Convective Heat and Mass Transfer

Pre-requisite(s): UG courses of Fluid Mechanics, Heat and Mass Transfer

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M.Tech

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Investigate innumerable cases under convection heat and mass transfer process in terms of similarity parameters. |
| 2. | Cover various applications, mathematical relations, analysis, heat transfer and flow & concentration parameters. |
| 3. | Perform performance studies and thermal design at industry level. |

Course Outcomes

At the end of this course, a student should be able to:

| | |
|-----|---|
| CO1 | Extend the similarity concept in velocity and thermal boundary layer for isothermal and non-isothermal cases. |
| CO2 | Examine the basics of turbulence model and analogy between flow field and heat transfer. |
| CO3 | Apply the boundary layer concept in pipe and duct flow for CHF and CWT conditions. |
| CO4 | Formulate and estimate free convection heat transfer for CHF and CWT conditions. |
| CO5 | Explain and estimate convective mass transfer and simultaneous heat and mass transfer |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module1:

Similarity concepts in heat transfer for laminar and turbulent flows; Boundary layer equations; Boundary layer integral equation; similarity and integral solutions of flow over isothermal and non-isothermal flat plate, Numerical solution of the laminar boundary layer flow over a flat plate and viscous dissipation effects on flow over a flat plate. (8L)

Module 2:

Introduction to Turbulent Flows: governing equations, mixing length turbulence models, analogy solutions for heat transfer in turbulent flows, near walls region, transition from laminar to turbulent flow, analogy solution for boundary layer flows, numerical solution of turbulent boundary layer equations, viscous dissipation effects on turbulent boundary layer flow over a flat plate. (8L)

Module3:

Fully developed pipe and plane duct flow under constant heat flux and constant wall temperature; Pipe flow with developing temperature field; Fully developed laminar flow in ducts with other cross-sectional shapes. (8L)

Module 4:

Concept of free convection for vertical, horizontal and inclined plate and cylinders at constant heat flux and constant wall temperature; free convection in finned surfaces and PCBs; free convection in horizontal, inclined and vertical plane enclosures and in horizontal, inclined and vertical concentric cylindrical enclosures. (8L)

Module 5:


Significant parameters in convective mass transfer, application of dimensional analysis to Mass Transfer, Analogies among mass, heat, and momentum transfer, Convective mass transfer correlations, Mass transfer between phases, Simultaneous heat and mass transfer. (8L)

Text Books:

1. Y. A. Cengel and A. J. Ghajar, Heat and Mass Transfer, McGraw-Hill Education, 2014.
2. P. H. Oosthuizen and D. Naylor, An Introduction to convective Heat Transfer Analysis, 1999.

References Books:

1. Frank P. Incropera, David P. Dewitt, Principles of Heat and Mass transferr, John Wiley & Sons, 2011.
2. William M. Kays & Michael E Crawford, Convective Heat and Mass Transfer, McGraw-Hill Science/Engineering/Math, 1993.


Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME572

Course title: Modern Power Plant Engineering

Pre-requisite(s): Power Plant Engineering (UG)

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Present a comprehensive and rigorous treatment of power plant and its component. |
| 2. | Lay the foundation of Non-conventional power plant system and its component to prepare the student to effectively use it in the practice of engineering. |
| 3. | Develop intuitive understanding of combined cycle power plant and its component. |
| 4. | Develop and explore intuitive understanding of nuclear power plant and its component. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Explain and analyse the working principle of various components and improvement of efficiency in a steam power plant |
| CO2 | Explain and analyse the nuclear power plant and its safety measures. |
| CO3 | Analyse and evaluate the performance of combined cycle and its exergy analysis for further improvement. |
| CO4 | Explain the working principle of non-conventional power plant. Understand the mechanism of nuclear fission reaction and working principle of various nuclear power plants. |
| CO5 | Explain different electrical components, operating characteristics of power plant and its improvements. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1

Steam powerplant: site selection, coal to electricity, general layout of thermal powerplant, high pressure boilers, waste heat boilers, boiler circulation theory, working principle of ESP, construction and working principles of main oil pumps, starting of oil pumps, AC, DC oil pumps, oil coolers, working principle and constructional detail of LP heaters, deaerators, HP heaters, HP/LP bypass circuit and its utility, various interlocks for operation, oil circuits in HP and LP bypass system, steam piping, design of steam piping, steam piping materials, insulation of steam piping. (10L)

Module 2

Nuclear powerplant: general components of nuclear reactor, heavy water reactors, breeder reactors, reactor containment design, cladding and structural materials, moderating and reflecting materials, control rod materials, shielding materials, Control and safety measures adopted in nuclear powerplant, types of nuclear wastes, radioactive wastes disposal systems, gas disposal systems. (5L)

Module 3

Combined cycle powerplant: introduction, classification of combined gas/ steam, mixed and cogeneration cycle, combined cycle powerplant in India, Various configurations of combined cycle powerplant, mixed cycle, thermodynamic analysis of combined cycle and cogeneration plant, advantage of combined-cycle power generation, exergy analysis of combined cycle. (9L)

Module 4


Non-conventional power generation: magneto hydro-dynamic power, thermo-ionic power generation, thermoelectric power generation, fuel cells, geo thermal energy, hydrogen energy system, solar power plant. (6L)

Module 5

Layout of electrical equipment, generator and exciter, switch gear installations, circuit breaker, relays, earthing of power system, protective devices and control systems used in powerplants, voltage regulation, selection of generating equipment, performance and operating characteristics of powerplants, load division, Definitions and different tariffs for domestic, commercial, industrial application, power factors and its effects, methods of improving powerplants. (10L)

Text Books

1. P. K. Nag, Power Plant Engineering, McGraw Hill publication, 2002.
2. M. M. EiWakil, Power Plant Technology, McGraw Hill publication, 2016.
3. F.T. Mores, Power Plant Engineering, D. Van Nostrand Company inc., 1953.

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME573

Course title: Design of Thermal Systems

Pre-requisite(s): Fluid Mechanics and Heat Transfer

Co- requisite(s): Nil

Credits: 3 **L:**3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M.Tech

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Design concepts and fundamental aspects of industrial thermal system simulation and optimization |
| 2. | Examine optimum design criteria. |
| 3. | Apply and scrutinise engineering decision. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Outline the thermal and material characteristics for selection of materials for thermal systems. |
| CO2 | Select suitable mathematical and physical model for different thermal equipment. |
| CO3 | Analyse numerical model for system simulation for accuracy and validation. |
| CO4 | Evaluate performance of thermal systems using optimization technique. |
| CO5 | Testing the thermal systems performance using neural network, fuzzy logic and genetic algorithm. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MBSRA, RANCHI-835215

SYLLABUS

Module 1: FORMULATION OF DESIGN PROBLEM

Engineering design, Design variables, Constraint or Limitation, Requirement and specifications, Conceptual design, Steps in design process, Material properties and thermal characteristics for thermal systems, Selection and substitution of materials. (9L)

Module 2: MODELLING OF THERMAL SYSTEMS

Basic features of modelling, Types of Models, Mathematical modelling, Physical modelling, Modelling Thermal equipment. (8L)

Module 3: NUMERICAL MODELING AND SIMULATION

Development of a numerical model, Modeling of individual components, Merging of different models, Accuracy and validation, System simulation, Dynamic simulation of lumped system and large system. (9L)

Module 4: ACCEPTABLE DESIGN OF THERMAL SYSTEM

Initial design, Design strategies, Application illustrations with suitable examples, Optimization of thermal systems. (7L)

Module 5: USE OF ARTIFICIAL INTELLIGENCE TECHNIQUES

Neural network, Fuzzy logic and genetic algorithm in thermal systems design and optimization with examples, Introducing idea of knowledge-based design in thermal systems. (7L)

Text Books


1. Design and Optimization of Thermal Systems, Y. Jaluria, R.C Press, 2007.
2. Optimization in Engineering Design, K. Deb, Prentice Hall, 2002.
3. Design of Thermal Systems, W.F Stoecker, McGraw-Hill, 1971.

Reference Books

1. Thermal Design and Optimization, Bejan, G. Tsatsaronis, M.J Moran, Wiley, 1996.
2. Design and Simulation of Thermal Systems, N.V. Suryanarayana, McGraw Hill, 2002.

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 574

Course title: Advanced Turbo-Machines

Pre-requisite(s): B.E. /B. Tech. Fluid Mechanics, Hydraulic Machines, Thermodynamics

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Present a comprehensive and rigorous treatment of classical turbomachinery while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as analysis of various turbomachines and energy conversion systems and to prepare the students to effectively use Fluid mechanics and thermodynamics theory in the practice of turbomachinery in engineering. |
| 3. | Develop an intuitive understanding of turbomachinery by emphasizing the engineering and engineering arguments. |
| 4. | Present a wealth of real world engineering examples to give students a feel for how turbomachinery theories are applied in engineering practice. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1 | Outline the fluid mechanics, thermodynamics concepts, system of control volume, to turbomachines |
| CO2. | Apply the appropriate fundamental laws of fluid dynamics, thermodynamics to various turbomachines |
| CO3. | Analyse various turbomachines for energy transfer |
| CO4. | Evaluate the performance of various turbomachines components |
| CO5. | Create optimum aerodynamic design/geometrical dimension of simple, complex turbomachines components using conventional methods and modern tools. |

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1

Introduction to turbomachines, classification of turbomachines, momentum, and moment of momentum theory applied to moving blades, change in total enthalpy and total pressure, velocity triangles for radial and axial flow turbomachines. Basic aerofoil theory applied to turbomachines, free, forced vortex and mean streamline theory, non-dimensional performance parameters, specific speed, flow coefficient and head coefficient. Concept of turbomachines design using modern tools like (T-AXI[®], AxSTREAM[®], CAESES[®], VISTA[®]) as a design tools. (8 L)

Module 2

Steam and gas turbines: Steam flow through nozzles, critical pressure ratio, and choking of nozzles, throat and exit areas for optimum discharge, impulse and reaction stage, flow of steam through turbine blades, velocity diagrams, stage and other efficiencies, condition for maximum efficiency of a single stage turbine, compounding of steam turbines. Axial flow gas turbines, stage losses, Soderbergs correlation, choice of reaction, pitch controlled blades, stress in turbine rotor blades, turbine characteristics and performance. (8L)

Module 3


Rotary Fans, Blowers and Compressors : Introduction,, centrifugal blower , types of vane shape , size and speed of machine, vane shape and efficiency, vane shape and stresses, vane shape and characteristics, actual performance characteristics, slip coefficient. Fan laws and characteristics, Centrifugal compressor, Performance of centrifugal compressors, compressibility and prewhirl, Axial flow compressor: compressor cascade, performance, axial-flow compressor performance, preheat in compressors, application of reversible rotary fan for ventilation and its performance. (8L)

Module 4

Hydraulic Turbines, hydraulic power utilization, hydrograph and water power, classification of water turbines, The Pelton wheel, velocity triangles, turbine efficiency and volumetric efficiency, working proportions of Pelton wheels , Francis and Deriaz turbines, velocity triangles and efficiencies, draft tube theory, cavitation, Propeller and Kaplan turbines, characteristics, application of aerofoil theory to propeller blades, design of Pelton, Francis and Kaplan turbine components. (8L)

Module 5

Centrifugal, Axial-Flow and Mixed flow pumps : Basic performance parameters, differential equations of the flow in a pump, flow kinematics in pumps, losses in pumps. Similarity laws of pumps, affinity laws, specific speed of a pumps, suction capability of pumps, cavitation in pumps, modeling of pumps, axial thrust and its balancing, radial thrust and its consequences, adjustment of pumps' work by changing of rotation speed and by swiveling of impeller's blades, Hydraulic design of a centrifugal, axial and mixed flow pumps, main dimensions'


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 575

Course title: Computational Fluid Dynamics

Pre-requisite(s): Fluid Mechanics and Heat Transfer, ME 562-Advanced

Incompressible Fluid Flow

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems |
| 2. | Provide the essential numerical background for solving the partial differential equations governing the fluid flow |
| 3. | Develop students' skills of writing the CFD codes and use of commercial software package to solve practical and theoretical problems |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|-----|---|
| CO1 | Understand the basic equations of fluid flow and heat transfer. |
| CO2 | Apply different methods of discretisation for solution of governing equation. |
| CO3 | Analyze convergence criteria used in multi-dimensional problem. |
| CO4 | Explain different schemes for convergence of convection diffusion problems. |
| CO5 | Evaluate Navier-Stokes equation by different algorithm. |



Professor & Head
Department of Mechanical Engineering
Birsa Institute of Technology
BESRA, RANCHI-835215

SYLLABUS

Module 1:

Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, A brief overview of the basic conservation equations for fluid flow and heat transfer, conservative and non-conservative forms of equation, classification of partial differential equations and pertinent physical behaviour, parabolic, elliptic and hyperbolic equations, role of characteristics. (7L)

Module 2:

Common methods of discretization: an overview of finite difference, finite element and finite volume methods. Numerical solution of parabolic partial differential equations using finite-difference and finite volume methods: explicit and implicit schemes, consistency, stability and convergence. Numerical solution of systems of linear algebraic equations: general concepts of elimination and iterative methods, Gaussian elimination, LU decomposition, tridiagonal matrix algorithm. (9L)

Module 3: Jacobi and Gauss-Seidel iterations, necessary and sufficient conditions for convergence of iterative schemes, gradient search methods, steepest descent and conjugate gradient methods. The finite volume method of discretization for diffusion problems: one dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization. Discretization of transient one-dimensional diffusion problems. (8L)

Module 4: Discretization for multi-dimensional diffusion problems. Solution of discretized equations using point and line iterations, strongly implicit methods and pre-conditioned conjugate gradient methods. Convection diffusion problems: Central difference, upwind, exponential, hybrid and power law schemes, concept of false diffusion, QUICK scheme. (8L)

Module 5: Numerical solution of the Navier-Stokes system for incompressible flows: stream-function vorticity and artificial compressibility methods, requirement of a staggered grid. MAC, SIMPLE, SIMPLEC and SIMPLER algorithms. An introduction to unstructured grid finite volume methods. Special topics: Turbulence and its modeling, interface/free-surface tracking methods. (8L)

Text Books

1. John A. Anderson, Jr., Computational Fluid Dynamics, The Basic with applications by
1. McGraw Hill International editions, Mechanical Engineering series, 2017.
2. Suhas Patankar, Numerical Methods in Fluid Flow & Heat Transfer, 1980.
3. H.K. Versteeg & W.Malalasekera, An Introduction to Computational Fluid Flow (Finite Volume Method), Printice Hall, 2008.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 576

Course title: Advanced Energy Technology

Pre-requisite(s): Thermodynamics

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

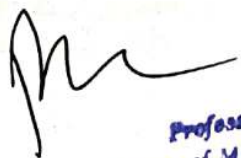
This course enables the students to:

| | |
|----|--|
| 1. | Provide basic knowledge of combined and cogeneration power cycle used for integrated power generation. |
| 2. | Gain knowledge and understanding of the principles involved in modern, developing and emerging forms of energy conversion and storage systems. |
| 3. | Gain knowledge about efficient systems which can result in significant reductions in energy consumption. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|-----|---|
| CO1 | Understand the working principle of combined and cogeneration power cycle used for integrated power generation. |
| CO2 | Understand different advanced energy storage systems. |
| CO3 | Apply different methods for production and applications of hydrogen energy and coal gas. |
| CO4 | Analyse economic and environmental aspects of energy conservation in power plants and waste heat recovery. |
| CO5 | Evaluating the performance characteristics and relative efficiency of fuel cells. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Total energy system for industry, Integrated gasification combined cycle plant, combined cycle power plant with cogeneration, fuels for combined cycle power plants. Natural gas cycles, Integrated power generation. Cogeneration principles. (10L)

Module 2:

Advanced energy storage systems – Mechanical energy storage, chemical energy storage, Electromagnetic energy storage, electrostatic energy storage, Thermal energy storage and biological storage. (7L)

Module 3:

Hydrogen Energy – Properties of hydrogen; hydrogen production – Thermo-chemical methods, Electrolysis of water, thermolysis of water and biophotolysis; Storage of hydrogen, delivery, conversion, applications and safety issues, present status. (7L)

Module 4:

Clean Coal technologies – Coal washing, gasification etc., application of coal gas in heat engines and gas turbines, Pressurized fluidized bed combustion. Coal bed methane. Energy conservation opportunities in power plants, economic and environmental aspects of energy conservation in power plants, economic load sharing of power plants, waste heat utilization. (10L)

Module 5:

Fuel Cell – Principles, classification of fuel cells, working of different types of fuel cells, fuels for fuel cells, Development stages and relative performances of various fuel cells, efficiency, V-I Characteristics of fuel cell, fuel cell power plant, environmental effects. (6L)

Text Books

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Sec. Ed.2000.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 577
Course title: Advanced Heat Transfer Lab
Co-requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M. Tech
Semester / Level: II/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Demonstrate the basic phenomenon of heat transfer. |
| 2. | Develop innovative methodologies of solving heat transfer problems |
| 3. | Compose precautionary measures while dealing with heat transfer equipment and problems. |

Course Outcomes

After the completion of this course, students will be able to:

| | |
|------|--|
| CO1. | Apply and demonstrate the basic laws of heat transfer under different modes. |
| CO2. | Analyze problems involving steady state heat transfer. |
| CO3. | Evaluate heat transfer coefficients under difference modes. |
| CO4. | Analyze heat exchanger performance under different conditions. |
| CO5. | Assess the importance of heat transfer coefficients and transferring medium. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESKA, KANPUR

List of experiments

Experiment 1: To determine the heat transfer coefficient on the internal surface of the pipe and compare it with respect to theoretical values (i) for different air flow rates (ii) for heat input

Experiment 2: To determine the efficiency and effectiveness of circular fin (i) for different air flow rates (ii) for different heat of the base.

Experiment 3: To verify the Stefan's Boltzmann law and to determine the emissivity of a gray body.

Experiment 4: To determine:

- (i) the characteristic curve of Peltier element and to find out its cooling and heating capacity.
- (ii) the coefficient of performance of Peltier device

Experiment 5: To determine the cooling rate of a heated rod within a bank of rods in a cross-flow heat exchanger and to find the average heat transfer coefficient over it.

Experiment 6: To demonstrate:

- (i) the effect of constant current source and constant voltage source on temperature measurement.
- (ii) Effect of two, three and four wire connection on temperature measurement in PRT.

Experiment 7: To demonstrate the super thermal conductivity of heat pipe made of stainless steel and to compare it with stainless steel and copper pipes for the same heat input.

Experiment 8: To demonstrate the effect of the air flow rate in the humidity measurement under humidifying and dehumidifying processes.

Experiment 9: To determination thermal contact resistance in a compound bar.

Experiment 10: To determine the thermal conductivity of a liquid by air calibration method.

Experiment 11: To determine the effect of the cross-section shape in the heat transfer from a fin.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RAIPUR, JHARHANDA

COURSE INFORMATION SHEET

Course code: ME 578

Course title: CFD Lab

Pre-requisite(s): Fluid Mechanics and Heat Transfer

Co-requisite(s): Nil

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M.Tech

Semester / Level: II/05

Branch: Mechanical Engineering (Heat Power Engineering)

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Provide exposure to different types of discretization techniques namely FDM and FVM |
| 2. | Apply computational methods for solving complex engineering problems. |
| 3. | Expose towards the different ways of time and space discretization techniques for solving different types of P.D.E's |
| 4. | Expose towards available postprocessing software (like Tecplot, gnuplot, etc) for postprocessing simulated results. |
| 5. | Be capable of solving problems of engineering interest using available application software. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Recognize the importance of CFD in Heat and Fluid flow |
| CO2 | Identify different types of boundary conditions |
| CO3 | Solve computational problems related to fluid flows and heat transfer |
| CO4 | Analyse how to apply different prebuilt Models in CFD |
| CO5 | Evaluate forced convection heat transfer coefficient over regular bodies like cylinder |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

List of Experiments

Experiment 1: To simulate a Simple Conduction Problem.

Experiment 2: To simulate a Mixed Boundary Problem (Conduction/ Convection/ Insulated).

Experiment 3: To simulate a Transient Thermal Conduction Problem.

Experiment 4: To do a Coupled Structural/Thermal Analysis.

Experiment 5: To simulate a Conjugate Heat Transfer Problem.

Experiment 6: To prepare a Computational Thermal Model of fluid flow in an elbow.

Experiment 7: To simulate fluid flow across a staggered uniformly-spaced tube arrangement.

Experiment 8: Understanding the simulation using Surface-to-Surface (S2S) Radiation Model.

Experiment 9: Simulation using the Discrete Ordinates Radiation Model.

Experiment 10: To simulate flow around an airfoil.

Experiment 11: To solve 1-D steady state conduction equation in Cartesian coordinate system (with and without source term).

Experiment 12: To solve Blasius Zero pressure gradient boundary layer equation using RK4 and shooting method.

Experiment 13: To solve 2-D steady state conduction equation using gauss seidel and Jacobi iteration methods.

Experiment 14: To solve 2-D steady state conduction equation using gauss seidel and Jacobi iteration methods.


Experiment 15: To solve 1-D steady state conduction equation using FTCS and Crank Nisholson scheme in time.

Experiment 16: To solve 1-D convection equation using Lax wendroff and Lax Friedrich scheme, compare and analyze the results obtained.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

 Professor & Head
Department of Mechanical Engineering
VIT Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME600

Course title: Thesis Part I

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 8 **L:** **T:** **P:**

Class schedule per week:

Class: M.Tech.

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Heat Power Engineering. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 642

Course title: Advanced Refrigeration and Air conditioning

Pre-requisite(s): Refrigeration and Air Conditioning

Co-requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: III/06

Branch: Mechanical Engineering)

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Explore the knowledge of solar geometry and heating load calculation of building for air conditioning purpose through different arrangements of building. |
| 2. | Examine and select different air conditioning system and their performance |
| 3. | Explore principle of design an air conditioning system and evaluate its components for their performance. |
| 4. | Design and recommend low cost and high-performance air conditioning duct, which finds applications in modern industries, homes and offices. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|-----|--|
| CO1 | Explain fundamental of solar geometry and heating load calculation by direct and diffuse radiations |
| CO2 | Interpret different heating sources of building and its calculations. |
| CO3 | Analyse different air conditioning systems and economic application. |
| CO4 | Specify, interpret data and design an air-conditioning system and its equipment in all aspect. |
| CO5 | Design and recommend low cost and high-performance air conditioning duct which finds applications in modern industries, homes and offices; recognize the need to learn, to engage and to adapt in a world of constantly changing in air conditioning industry. |

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Cooling and Heating Load Calculations - I: Estimation of Solar Radiation : Introduction to cooling and heating load calculations, Refrigeration loads due to Solar radiation and Solar geometry, Air mass system, Calculation of direct, diffuse and reflected radiation using ASHRAE solar radiation model and Air mass system, Effect of clouds. (8L)

Module 2:

Cooling and Heating Load Calculations –II: Solar Radiation Through Fenestration Ventilation And Infiltration Need for fenestration in buildings and effects of fenestration on air conditioning systems, concepts of Solar Heat Gain Factor (SHGF) and Shading Coefficient, calculation of shaded area of fenestrations, Need for ventilation and recommended ventilation rates, Infiltration and causes for infiltration, Estimation of heat transfer rate due to infiltration and ventilation, comparison between natural ventilation and mechanical ventilation, characteristics of natural ventilation and estimation of airflow rate due to wind and stack effects, general guidelines for natural ventilation and forced ventilation using electric fans, interior air movement using interior fans. (8L)

Module 3:

Cooling and Heating Load Calculations - III: Heat Transfer Through Buildings - Fabric Heat Gain/Loss General aspects of heat transfer through buildings, steady state heat transfer through homogeneous, non-homogeneous walls, opaque walls and roofs with suitable initial and boundary conditions, semi-empirical methods based on Effective Temperature Difference or Cooling Load Temperature Difference, discuss the physical significance of decrement and time lag factors and present typical tables of CLTD for walls and roof. (8L)

Module 4:

Selection of Air Conditioning Systems: Introduction to thermal distribution systems and their functions, Selection criteria for air conditioning systems, Classification of air conditioning systems, Working principle, advantages, disadvantages and applications of all air systems, e.g. single duct, constant volume, and single/multiple zone system, single duct, dual duct, constant & variable air volume (VAV) systems, outdoor air control in all air systems, advantages/disadvantages & applications of all air systems, working principle, advantages, disadvantages and applications of all water systems, air-water systems, working principle, advantages, disadvantages and applications of unitary refrigerant based systems. (9L)

Module 5:

Transmission of Air in Air Conditioning Ducts: Air Handling Unit (AHU) and its functions, need for transmission aspects of air in air conditioning, airflow through air conditioning ducts, Bernoulli and modified Bernoulli equations, Static, dynamic, datum and total head, Fan Total Pressure (FTP) and power input to fan, estimation of pressure loss through air conditioning ducts,, Estimation of frictional pressure drop of circular and rectangular ducts using friction charts and equations, Estimation of dynamic pressure drop in various types of fittings, Static regain, Important requirements of an air conditioning duct, General rules for duct design, Classification of duct systems, Commonly used duct design methods, Principle of velocity method, Principle of equal friction method, Principle of static regain method. (9L)


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESBA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 643

Course title: Dynamics of Compressible Fluid Flow

Pre-requisite(s): Fluid Mechanics, Thermodynamics, ME 562-Advanced Incompressible Fluid Flow

Co-requisite(s):

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Present a comprehensive and rigorous treatment of classical compressible fluid dynamics while retaining an engineering perspective. |
| 2. | Give base for studies in fields such as analysis of compressible flow and to prepare the students to effectively use Compressible flow theory in the practice of engineering. |
| 3. | Develop an intuitive understanding of Compressible flow by emphasizing the engineering and engineering arguments. |
| 4. | Present a wealth of real world engineering examples to give students a feel for how Compressible flow is applied in engineering practice. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|-----|---|
| CO1 | Outline the concepts of continuum, system of control volume, compressible fluid and its flow properties. |
| CO2 | Apply the appropriate fundamental laws of fluid dynamics and thermodynamics to Compressible flow dynamics and various fluid flow devices. |
| CO3 | Analyse various Compressible fluid flow problems. |
| CO4 | Evaluate the performance of various fluid flow geometry where fluid flow is compressible in nature. |
| CO5 | Create design of simple(2D), complex(2D) compressible fluid flow geometries using conventional methods and modern tools |

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Fundamentals of compressible flow, concepts from fluid mechanics, compressibility, thermodynamic concepts, conservation equations, stagnation state pressure waves in gases, differential equations for 1d flow isentropic flow with area variations, numerical examples. (8L)

Module 2:

Normal Shock Concept, development of a shock wave, governing equations for normal Shock, mach number downstream of normal shock, static pressure ratio across the shock, temperature ratio across the shock, density ratio across the shock, stagnation pressure ratio across the shock, change in entropy across the shock, strength of a shock wave, moving shock waves, numerical examples. (8L)

Module 3:

Concept and theory of oblique shock, oblique Shock relations, property variations across oblique shock, detached shocks, shock-shock interactions, shock reflections, 1-D expansion wave, expansion fan, Prandtl Meyer function, smooth expansions and compressions, numerical examples. (8L)

Module 4:

Flow in Constant Area Duct with Friction - Fanno curves, Fanno flow equations, solution of Fanno flow equations, variation of flow properties, change of entropy, variation of mach number with duct length, isothermal flow in a constant area duct with friction, isothermal flow equations, variation of flow properties, numerical examples. (8L)

Module 5:

Flow in constant area ducts with heat transfer and without friction (Rayleigh flow) - Rayleigh line, constant entropy lines, constant enthalpy lines, general equations in Rayleigh flow process, Rayleigh flow relations, variation of flow properties, maximum heat transfer, numerical examples. Case study on capturing of shock using softwares. (8L)

Text Books

1. S. M. Yahya, Fundamentals of Compressible Flow, New Age International Publishers, 2018.
2. V. Babu, Fundamentals of Gas Dynamics, Ane Books India, 2014
3. A. H. Shapiro, The Dynamics and Thermodynamics of Compressible Flow, McGraw-Hill Publishing Co., 2017.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 644

Course title: Design and Analysis of Heat Exchangers

Pre-requisite(s): Heat and Mass Transfer.

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: III/06

Branch: Mechanical Engineering

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Familiarize with the various applications of heat exchangers. |
| 2. | Lay the groundwork for subsequent studies in construction, design, performance and testing of Heat Exchangers. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1 | Outline the physics of the Heat Exchangers. |
| CO2 | Analyze the mathematical treatment of typical heat exchangers. |
| CO 3 | Apply LMTD methods in the design of heat exchangers and analyze the importance of LMTD approach over AMTD approach. |
| CO 4 | Evaluate the Effectiveness of the heat exchangers and analyze the performance of double-pipe counter flow (hair-pin) heat exchangers. |
| CO5 | Design and analyze the shell and tube heat exchanger and classify cooling towers and explain their technical features. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1

Introduction to Heat Exchangers: Definition, Applications, Various methods of classification of heat exchangers with examples. (7L)

Module 2

General Back-bone Equation for heat exchangers: Derivation from steady-state steady-flow considerations.

Mathematical treatment of Heat Exchangers: Concept of Overall Heat Transfer Coefficient, Derivation of the concerned equations, Fouling, Fouling Factor, Factors contributing to fouling of a heat exchanger, Effects of fouling. (8L)

Module 3

Logarithmic Mean Temperature Difference: Expression for the same for single pass parallel-flow and single-pass counter flow heat exchangers – Derivation from first principles, Special Cases, LMTD for a single-pass cross-flow heat exchanger – Nusselt's approach, Chart solutions of Bowman et al. pertaining to LMTD analysis for various kinds of heat exchangers, Arithmetic Mean Temperature Difference [AMTD], Relation between AMTD and LMTD, Logical Contrast between AMTD and LMTD, LMTD of a single-pass heat exchanger with linearly varying overall heat transfer coefficient [U] along the length of the heat exchanger. (9L)

Module 4

Hair-Pin Heat Exchangers: Introduction to Counter-flow Double-pipe or Hair-Pin heat exchangers, Industrial versions of the same, Film coefficients in tubes and annuli, Pressure drop, Augmentation of performance of hair-pin heat exchangers, Series and Series-Parallel arrangements of hair-pin heat exchangers, Comprehensive Design Algorithm for hair-pin heat exchangers.

Effectiveness: Effectiveness-Number of Transfer Units Approach, Derivations of expressions for effectiveness of single-pass parallel-flow and counter-flow heat exchangers, Physical significance of NTU, Heat capacity ratio, Different special cases of the above approach, Chart solutions of Kays and London pertaining to Effectiveness-NTU approach. (9L)

Module 5

Optimum Design: Criteria for optimisation of heat exchangers, constraints, feasible and optimum design, optimization based on volume, weight, cost, entropy generation and thermoeconomics; Brief introduction to some traditional and non-traditional optimisation techniques. (7L)

Text books:

1. Donald Q. Kern, Process Heat Transfer, McGraw – Hill, New York (1983).
2. F. P. Incropera and D. P De Witt, Fundamentals of Heat and Mass Transfer John Wiley and Sons, New York (2012).

Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215



COURSE INFORMATION SHEET

Course code: ME 645

Course title: Steam Engineering

Pre-requisite(s): Thermodynamics.

Co-requisite(s):

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| A. | Familiarize with the applications of steam engineering in different thermal systems. |
| B. | Lay the groundwork for subsequent studies in construction, design, performance and testing of different thermal systems. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|----|--|
| 1. | Familiarize with the working of different boilers and significance of mountings and accessories. |
| 2. | Design a steam piping system, its components for a process and also design economical and effective insulation |
| 3. | Analyze the different thermal systems for energy conservation |
| 4. | Use techniques, skills, and modern engineering tools necessary for boiler performance assessment |
| 5. | Design and develop controls and instrumentation for effective monitoring of the process. |

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1

Introduction: Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart, Boilers Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards. (9L)

Module 2

Piping & Insulation: Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss. (8L)

Module 3

Steam Systems: Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems. (7L)

Module 4

Boiler Performance Assessment: Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance, Boiler terminology. (8L)

Module 5

Instrumentation & Control: Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection. (8L)

Text Books

1. T. D. Eastop and A. McConkey, Applied Thermodynamics, Parson Publication, 2009.
2. Yunus A. Cengel and Boles, Engineering Thermodynamics Tata McGraw-Hill Publishing Co. Ltd., 2005,
3. Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency.(<http://www.em-ea.org/gbook1.asp>)

Reference Books

1. Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency.(<http://www.em-ea.org/gbook1.asp>)
2. J. B. Kitto and S C Stultz, Steam: Its Generation and Use, The Babcock and Wilcox Company, 2005.
3. P. Chatopadhyay, Boiler Operation Engineering: Questions and Answers, Tata McGrawHill Education Pvt Ltd, N Delhi, 2001.

Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215



COURSE INFORMATION SHEET

Course code: ME 646

Course title: Thermal Engineering Lab

Pre-requisite(s): I.C Engines, refrigeration and solar energy

Co- requisite(s):

Credits: 2 L: 0 T:0 P: 4

Class schedule per week: 04

Class: M. Tech

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Be familiar with various types Internal Combustion Engines, different measurement systems, refrigeration system and solar radiation equipment. |
| 2 | Be confident on how to perform experiments related Internal Combustion Engines, different measurement systems, refrigeration system and solar radiation equipment. |
| 3. | Study performance characteristics of various I.C. Engines, refrigeration systems and solar radiation equipment. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the procedure to conduct experiments related to Internal Combustion Engines, different measurement systems, refrigeration system and solar radiation equipment. |
| CO2. | Interpreting various parameters influence the performance of the Internal Combustion Engines, refrigeration and solar energy equipment |
| CO3. | Analyze the observations made through experiments |
| CO4. | Apply the experimental knowledge how to perform the experiments in different manner. |
| CO5. | Predicting the sources of errors and minimising them in the experiments |

List of experiments:

Experiment 1: Performance study and analysis of Combustion characteristics (P- θ) diagram of 3-cylinder, 4-stroke M.P.F.I. petrol engine.

Experiment 2: Performance study with bended fuel on Mahindra 4-cylinder, 4-stroke Diesel engine.

Experiment 3: Analysis of exhaust gas emission on Diesel and Petrol Engine using AVL gas analysis.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Experiment 4: Performance evaluation of vapour absorption refrigeration system.

Experiment 5: Performance evaluation of variable load refrigeration rig at different flow rate of refrigerant and evaporator temperature.

Experiment 6: Performance evaluation of Peltier element at different flow rate of water in cooling and heating side of heat exchanger

Experiment 7: To study the working principle of different types of pyranometer and measurement of intensity of solar radiation.

Experiment 8: To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.

Experiment 9: To demonstrate the I-V and P-V characteristics of series and parallel combination of PV module.

Experiment 10: Performance study of thermos siphon type solar water heater.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Professor, & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215



COURSE INFORMATION SHEET

Course code: ME650
Course title: Thesis Part II
Pre-requisite(s): Nil
Co-requisite(s): Nil
Credits: 16 **L:** **T:** **P:**
Class schedule per week:
Class: M.Tech.
Semester / Level: IV/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

**DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI**
Courses of Studies for M.Tech. Programme in Energy Technology

| | L | T | P | C | |
|---|---|----------|----------|----------|-----------|
| Semester - I | | | | | |
| Theory courses | | | | | |
| TET 1001 | Foundation for Energy Engineering | 3 | 0 | 0 | 3 |
| TET 1005 | Energy Systems Modeling and Analysis | 3 | 1 | 0 | 4 |
| TET 1009 | Wind Energy Conversion Systems | 3 | 0 | 0 | 3 |
| Elective I - Any one | | | | | |
| TET 1003 | Non-Conventional Energy | 3 | 0 | 0 | 3 |
| TET 1007 | Solar Energy Technology | 3 | 0 | 0 | 3 |
| TET 1011 | Alternative Fuel Technology | 3 | 0 | 0 | 3 |
| Breadth Subject – Any one | | 3 | 0 | 0 | 3 |
| Sessional | | | | | |
| TET 1002 | Non-Conventional Energy Laboratory | 0 | 0 | 3 | 2 |
| TET 1004 | Elective course work | 0 | 0 | 3 | 2 |
| ----- | | | | | |
| 20.00 | | | | | |
| Semester - II | | | | | |
| TET 2005 | Energy Management | 3 | 1 | 0 | 4 |
| TET 2003 | Waste to Energy | 3 | 0 | 0 | 3 |
| TET 2001 | Direct Energy Conversion | 3 | 0 | 0 | 3 |
| TET 2007 | Advanced Energy System | 3 | 0 | 0 | 3 |
| Breadth Subject – (Credit 03, Any one) | | | | | 03 |
| Sessional | | | | | |
| TET 2008 | Energy Auditing of different Energy system. | 0 | 0 | 3 | 2 |
| TET 2014 | SPV System Design Course work | 0 | 0 | 3 | 2 |
| Semester - III | | | | | |
| Thesis | | 0 | 0 | 0 | 15 |
| Semester - IV | | | | | |
| Thesis | | 0 | 0 | 0 | 20 |
| ----- | | | | | |
| Total Credits | | | | | 75 |

TET 1001 Foundation for Energy Engineering

Module 1: Thermodynamics: first law and its application, second law and its application, Irreversibility and energy, basic power generation cycles. (5 periods)

Module 2: Fluid Mechanics: Properties of fluids and constitutive equations; flow through pipes. (5 periods)

Module 3: Heat Transfer: conduction, radiation and convective heat transfer. (6 periods)

Module 4: Introduction to thermal, hydel and nuclear power generation. (5 periods)

Module 5: Network analysis: simple network analysis, power factor improvement. (5 periods)

Module 6: Electrical Machines: Transformer, Induction motor and generators, Synchronous generators. (5 periods)

Module 7: Power systems: Introduction to power generation, transmission and distribution. (5 periods)

Text books:

1. M. W. Zemansky, Heat and Thermodynamics 4th Edn. McGraw Hill, 1968.
2. L. Prasuhn, Fundamentals of Fluid Mechanics, Prentice Hall, 1980
3. S. P. Sukhatme, A Text book on Heat Transfer, Orient Longman, 1979.
4. P. C. Sen, Modern Power Electronics, Wheeler, New Delhi, 1998.
5. N. Balbanian, T. A. Bickart, Electrical network theory, John Wiley, New York, 1969
6. B. L. Theraja, A. K. Theraja, Text-book of electrical technology: in S.I. units: v.2 AC and DC machines, Nirja Construction & development, New Delhi, 1988.
7. Domekundwar, Power Plant Engineering.
8. P.K. Nag, Power Plant Engineering.

TET 1005 Energy Systems Modeling and Analysis

Module 1: Modelling overview-levels of analysis, steps in model development, examples of models. Quantitative Techniques: Interpolation-polynomial, Lagrangian. Curve-fitting, regression analysis, solution of transcendental equations. (5 periods)

Module 2: Systems Simulation-information flow diagram, solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson. (5 periods)

Module 3: Examples of energy systems simulation; Optimisation: Objectives/constraints, problem formulation; Linear programming: simplex algorithm. (5 periods)

Module 4: Primal – Dual relationship; Dual simplex algorithm; sensitivity analysis. (5 periods)

Module 5: Classical optimization theory: unconstrained problems – necessary and sufficient condition; constraint problems – equality constraints, inequality constraints – Karush – Kuhn – Tucker conditions. (5 periods)

Module 6: Deterministic dynamic programming; unconstrained algorithms – direct search method, gradient method; constrained algorithms – separable programming, quadratic programming; case studies of optimization in energy systems problems. (5 periods)

Module 7: Energy- Economy Models: Scenario Generation, Input Output Model; Numerical solution of Differential equations - Overview, Convergence, Accuracy; application oriented examples. (5 periods)

Text books/ Reference books

1. W. F. Stoecker Design of Thermal Systems, Mcgraw Hill, 1981
2. Hamdy Taha, Operations Research – An introduction, 8th edition, Pearson Education, 2009.
3. Hiller and Libbermann, Operations Research, 8th edition, Tata McGraw Hill, 2009.
4. Gerald and Wheatley, Numerical Methods for Scientists and Engineers, 6th edition, Pearson Education, 2007
5. R.de Neufville, Applied Systems Analysis, Mcgraw Hill, International Edition, 1990
6. S.S.Rao Optimisation theory and applications, Wiley Eastern, 1990
7. S.S. Sastry Introductory methods of numerical analysis, Prentice Hall, 6th edition, 2007.

TET 1009 Wind Energy Conversion Systems

Module 1: Wind machine types, classification, parameters. Wind, its structure, statistics, measurements, data presentation, power in the wind. (5 periods)

Module 2: Wind turbine aerodynamics, momentum theories, basic aerodynamics, airfoils and their characteristics, Horizontal Axis Wind Turbine (HAWT) - Blade Element Theory, wake analysis, Vertical Axis Wind Turbine (VAWT) aerodynamics. (5 periods)

Module 3: HAWT rotor design considerations, number of blades, blade profile, 2/3 blades and teetering, coning, power regulation, yaw system, tower. (5 periods)

Module 4: Wind turbine loads, aerodynamic loads in steady operation, wind turbulence, static - dynamic - fatigue analysis, yawed operation and tower shadow, WECS control system, requirements and strategies. (5 periods)

Module 5: Wind Energy Conversion System (WECS): Siting and rotor selection, Annual Energy Output (AEO), Environmental consideration. (5 periods)

Module 6: Synchronous and asynchronous generators; Grid interactive and stand alone systems, storage systems. (5 periods)

Module 7: Testing of WECS. Noise. Miscellaneous topics. (5 periods)

Text Books:

1. Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
2. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.
3. Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985.

TET 1003 Non-Conventional Energy

- Module 1:** Energy Alternatives: Solar, Nuclear, Wind, Tidal, Geothermal & Biomass Energy options. (5 periods)
- Module 2:** Solar Radiation, availability, measurement and estimation. (5 periods)
- Module 3:** Solar Thermal Conversion Devices and Storage, Applications. (5 periods)
- Module 4:** Solar Photovoltaic conversion. (5 periods)
- Module 5:** Tidal, Ocean thermal and Geothermal Energy Conversion. (5 periods)
- Module 6:** Wind Energy Conversion, Biomass Energy Conversion. (5 periods)
- Module 7:** Energy from Waste, Mini/Micro-hydel. (5 periods)

Text Books:

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hill, New Delhi, 1996
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
4. D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.
5. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, 1986.

TET 1007 Solar Energy Technology

Module 1: Fundamentals of Solar Radiation: thermal radiation fundamentals, sun-earth geometric relationship, estimation of terrestrial solar radiation, models based on long term measured horizontal solar radiation, measurement of solar radiation. (5 periods)

Module 2: Methods of solar collection and thermal conversion: radiative properties and characteristics of materials, flat plat and concentrating solar collectors. (5 periods)

Module 3: Thermal Energy Storage and Transport: thermal energy storage and their types, design of storage system, energy transport subsystems. (5 periods)

Module 4: Solar Devices: solar heating systems, solar cooling and dehumidification, passive methods for heating, cooling and daylighting. (5 periods)

Module 5: Photovoltaics: semiconductors, analysis of photovoltaic cells, manufacture of solar cells and panels, design for Grid interactive and stand alone photovoltaic applications.(5 periods)

Module 6: Solar photochemical applications: photocatalytic reactions, solar reactors, kinetic models, catalyst development, system design methodology, commercial/industrial applications. (5 periods)

Module 7: Capturing solar energy through biomass: biomass feedback, thermodynamic calculations for biomass energy, conversion of biomass to gaseous and liquid fuels and electricity, overview of solar economics. (5 periods)

Text books:

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Sec. Ed.2000.
2. G. Rai, Non-Conventional Energy Sources, Khanna Publishers.

TET 1011 Alternative Fuel Technology

Module 1:

Alternative Fuels: Depletion of fossil fuel and potential, Alternative fuels, Alcohols, Hydrogen, Non-edible vegetable oils, Biogas, producer gas, Blast furnace gas and water gas. (5 Lectures)

Module 2:

Methods of production, properties of alternative fuels, organic substances with high calorific value and the possibility of their use as fuels, raw materials. (5 Lectures)

Module 3:

Fermentation System, Gasification of wood, Gasification and shift Conversion, Biogas, Fuel properties of biogas, utilization of biogas. (5 Lectures)

Module 4:

Biomass as a source of energy, methods of obtaining energy from biomass, thermal gasification of biomass, chemistry of gasification process. (5 Lectures)

Module 5:

Hydrogen, eco-friendly hydrogen as source of energy, production of hydrogen – electrolysis, thermo-chemical method, other methods, Storage of hydrogen gas, liquid and solid modes, transportation of hydrogen and its utilization, applications. (6 Lectures)

Module 6:

Recycling and recovery of waste energy, its potential applications, waste energy recovery systems, technological improvement. Case Study. (4 Lectures)

Module 7:

Impact of alternative fuel utilization on the environment, Decarbonization of fossil fuel by CO₂ capture. Generation of hydrogen from fossile fuels with simultaneous CO₂ sequestration. (5 Lectures)

Text Books:

1. J. Twidell and T. Weir, Renewable Energy Resources, E & FN Spon Ltd., London, 1986.
2. Fuels from Waste by Larry L, Anderson & David A.
3. Hydrogen Energy System, T. Ohta, Pergamon Press.
4. I.C. Engine & Gas Turbine –V Ganesan.
5. Energy from Solid Waste by Frederick R. Jackson.

TET 2005 Energy Management

Module 1: Energy needs and past & future estimates of energy demands; Resource base and reserves; global distribution and energy content of proven reserves; Industrial and commercial energy sources and use pattern changes with technological changes; representation of energy consumption through pie chart, Sankey diagram and load profile. Technology for improved recovery and utilization of energy and materials. (5 Periods)

Module 2: Objectives and salient features of national energy policy/strategy; essential steps in energy planning; Needs, objectives and significance of energy management; design of effective energy management program, role of energy manager and typical organization set up for energy management program and starting of an energy management program. (5 Periods)

Module 3: Energy accounting and Energy utilization index; Energy conservation, Principles, energy conservation schemes and its various aspects, Salient features of energy conservation act; Energy audit, energy audit classification, phases of energy audit and its beneficial effects. Preparation of audit report. (5 Periods)

Module 4: Load management (supply and demand side management), power factor; Economics of power generation and Tariff; Economic analysis and life cycle costing of energy projects for cost-effectiveness; energy payback period. (5 Periods)

Module 5: Common energy management opportunities in lighting systems; Heating, ventilation and refrigeration system; combustion processes; steam generation and distribution system; thermal insulation; energy systems maintenance; Process energy management and renewable energy systems management. (5 Periods)

Module 6: Energy analysis and thermodynamics, energy cost of fuel and materials, methods of energy analysis, energy analysis of real industrial system. Transportation system and energy requirement of production system. Energy and exergy analysis. (5 Periods)

Module 7: Recovery of waste energy and its potential applications, waste heat recovery systems and its optimal utilization, Technological improvement and increased efficiency. (5 Periods)

Text books:

1. W. R. Murphy and G. McKay, Energy Management, Butterworths London.
2. Paul O'Callaghan, Energy Management, McGraw Hill Book Company.
3. I.G.C.Dryden, Butterworths, The Efficient Use of Energy, London.
4. W.C.Turner, Wiley, Energy Management Handbook, New York.

TET 2003 Waste to Energy

Module 1: Introduction to energy from waste: characterisation and classification of waste as fuel – agrobased, forest residues, industrial waste, Municipal solid waste. (5 periods)

Module 2: Waste to energy options: combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis. (5 periods)

Module 3: Conversion devices: combustors (Spreader Stokes, Moving grate type, fluidized bed), gasifier, digesters. (5 periods)

Module 4: Briquetting technology: Production of RDF and briquetted fuel. (5 periods)

Module 5: Properties of fuels derived from waste to energy technology: Producer gas, Biogas, Ethanol and Briquettes, Comparison of properties with conventional fuels. (5 periods)

Module 6: Power generation using waste to energy technologies: Reciprocating Engines and Gas Turbines. (5 periods)

Module 7: Landfills: Gas generation and collection in land fills, Introduction to transfer stations. (5 periods)

Text Books:

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.

TET 2001 Direct Energy Conversion

Module 1: Energy conversion process, indirect and direct energy conversion. (4 periods)

Module 2: Preview of semiconductor physics: Basic ideas of quantum physics, Fermi Energy, band diagram, Intrinsic and extrinsic semiconductors, p-n junction. (6 periods)

Module 3: Introduction to irreversible thermodynamics. (4 periods)

Module 4: Thermoelectric conversion: thermoelectric effects, analysis of thermoelectric generators and coolers, figure of merit, device configuration. (5 periods)

Module 5: Photovoltaic conversion: Optical effects of p-n junction, design and analysis of PV cells. PV cell fabrication, System design. (5 periods)

Module 6: Thermionic conversion: thermionic effects, analysis of converters, application of heat pipes. Magnetohydrodynamic conversion: gaseous conductors, analysis of MHD generators. (6 periods)

Module 7: Batteries and fuel cell: Thermodynamic analysis, design and analysis of batteries and fuel cells. Other modes of direct energy conversion. (5 periods)

Text Books:

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970
2. Angrist S.W. ,Direct Energy Conversion. 4th Ed. Allyn And Bacon, Boston, 1982
3. Green M.A. ,Solar Cells, Prentice-Hall, Englewood Cliffs, 1982
4. Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.

TET 2007 **Advanced Energy Systems**

Module 1: Total energy system for industry, Integrated gasification combined cycle plant, combined cycle power plant with cogeneration, fuels for combined cycle power plants.

(5 periods)

Module 2: Advanced energy storage systems – Mechanical energy storage, chemical energy storage, Electromagnetic energy storage, electrostatic energy storage, Thermal energy storage and biological storage.

(5 periods)

Module 3: Hydrogen Energy – Properties of hydrogen; hydrogen production – Thermo-chemical methods, Electrolysis of water, thermolysis of water and biophotolysis; Storage of hydrogen, delivery, conversion, applications and safety issues, present status.

(5 periods)

Module 4: Clean Coal technologies – Coal washing, gasification etc., application of coal gas in heat engines and gas turbines, Pressurized fluidized bed combustion. Coal bed methane.

(5 periods)

Module 5: Fuel Cell – Principles, classification of fuel cells, working of different types of fuel cells, fuels for fuel cells, Development stages and relative performances of various fuel cells, efficiency, V-I Characteristics of fuel cell, fuel cell power plant, environmental effects.

(5 periods)

Module 6: Natural gas cycles, Integrated power generation. Cogeneration principles. (4 periods)

Module 7: Energy conservation in Power plants – energy conservation opportunities in power plants, economic and environmental aspects of energy conservation in power plants, economic load sharing of power plants, waste heat utilization.

(6 periods)

Text Books:

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Sec. Ed.2000.
4. G. Rai, Non-Conventional Energy Sources, Khanna Publishers.
1. Fuel Cells, by W. Vielstich, translated by D. J. G. Ives, Willey Interscience, 1965.
2. Microbial Fuel Cells, by B. E. Logan, John Willey & Sons, 2008.
3. I. Boustead and G. F. Hancock, Handbook of Industrial Energy Analysis, Ellis Horwood Ltd., A division of John Wiley and Sons, 1979.


BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for all M.Tech in Energy Technology Engineering

| SEMESTER / Session of Study (Recommended) | Course Level | Category of course | Course Code | Courses | Mode of delivery & credits L-Lecture; T-Tutorial; P- Practicals | | | Total Credits C- Credits | | |
|---|---|---|-------------|------------------------------------|---|---|-------------------------|--------------------------------|-----------|---|
| | | | | | L (Periods/ week) | T (Periods/ week) | P (Periods/ week) | C | | |
| FIRST / Monsoon | FIFTH | THEORY | | | | | | | | |
| | | Programme Core (PC) | ME541 | Renewable Sources of Energy | 3 | 0 | 0 | 3 | | |
| | | | ME542 | Fuel Technology | 3 | 0 | 0 | 3 | | |
| | | | ME543 | Energy Conversion System | 3 | 0 | 0 | 3 | | |
| | | Programme Elective (PE)*(* Student can choose only one of these) | ME544 | Wind Energy | 3 | 0 | 0 | 3 | | |
| | | | ME545 | Solar Passive Architecture | 3 | 0 | 0 | 3 | | |
| | | | ME546 | Hydrogen Energy System | 3 | 0 | 0 | 3 | | |
| | | Open elective OE | | Open Elective (OE) I | 3 | 0 | 0 | 3 | | |
| | | LABORATORIES | | | | | | | | |
| | | Programme Core (PC) | ME547 | Energy Laboratory I | 0 | 0 | 4 | 2 | | |
| | | | ME548 | Computational Lab | 0 | 0 | 4 | 2 | | |
| | | TOTAL | | | | | | | 19 | |
| | | SECOND/ Spring | FIFTH | THEORY | | | | | | |
| | | | | Programme Core (PC) | EE597 | Power Generation, Transmission and Distribution | 3 | 0 | 0 | 3 |
| ME553 | Economics and Planning of Energy Systems | | | | 3 | 1 | 0 | 4 | | |
| ME554 | Energy Management and Auditing | | | | 3 | 1 | 0 | 4 | | |
| Programme Elective (PE)*(* Student can choose only one of these) | ME555 | | | Energy Storage Technology | 3 | 0 | 0 | 3 | | |
| | ME556 | | | Convection Heat & Mass Transfer | 3 | 0 | 0 | 3 | | |
| | ME557 | | | Integrated Energy System | 3 | 0 | 0 | 3 | | |
| OPEN ELECTIVE OE | | | | Open Elective (OE) 2 | 3 | 0 | 0 | 3 | | |
| LABORATORIES | | | | | | | | | | |
| Programme Core (PC) | ME558 | | | Energy Laboratory II | 0 | 0 | 4 | 2 | | |
| TOTAL | | | | | | | 19 | | | |
| TOTAL FOR FIFTH LEVEL | | | | | | | 38 | | | |



 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215


| | | | | | | | | |
|--|--------------|---|--------|---------------------------------------|---|-----------|---|-----------|
| THIRD / Monsoon | SIXTH | THEORY | | | | | | |
| | | Programme Core (PC) | ME 600 | Thesis Part I | | | | 8 |
| | | | ME 639 | Energy Simulation and Modelling | 3 | 0 | 0 | 3 |
| | | Programme Elective (PE)* (* Student can choose only one of these) | ME622 | Bioconversion and Processing of Waste | 3 | 0 | 0 | 3 |
| | | | ME623 | Solar Photovoltaic System | 3 | 0 | 0 | 3 |
| | | | ME624 | Nuclear Energy | 3 | 0 | 0 | 3 |
| | | | ME625 | Energy, Ecology and Environment | 3 | 0 | 0 | 3 |
| | | LABORATORIES | | | | | | |
| | | Programme Core (PC) | ME627 | Simulation Lab | 0 | 0 | 4 | 2 |
| | | TOTAL | | | | | | 16 |
| FOURTH/ Spring | SIXTH | THEORY | | | | | | |
| | | Programme Core (PC) | ME650 | Thesis Part II | | | | 16 |
| | | TOTAL | | | | | | 16 |
| TOTAL FOR SIXTH LEVEL | | | | | | 32 | | |
| GRAND TOTAL FOR MTECH PROGRAMME (38 + 32) | | | | | | 70 | | |


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

**DEPARTMENT OF MECHANICAL ENGINEERING
PROGRAMME ELECTIVES (PE) Mtech in Energy Technology
OFFERED FOR LEVEL 5-6**

| PE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|------------|----------|---------------------------------------|---------------------------------|---|---|---|---|
| 5 | ME544 | Wind Energy | NIL | 3 | 0 | 0 | 3 |
| | ME545 | Solar Passive Architecture | NIL | 3 | 0 | 0 | 3 |
| | ME546 | Hydrogen Energy System | NIL | 3 | 0 | 0 | 3 |
| | ME555 | Energy Storage Technology | NIL | 3 | 0 | 0 | 3 |
| | ME556 | Convection Heat & Mass Transfer | NIL | 3 | 0 | 0 | 3 |
| | ME557 | Integrated Energy System | NIL | 3 | 0 | 0 | 3 |
| 6 | ME622 | Bioconversion and Processing of Waste | NIL | 3 | 0 | 0 | 3 |
| | ME623 | Solar Photovoltaic System | NIL | 3 | 0 | 0 | 3 |
| | ME624 | Nuclear Energy | NIL | 3 | 0 | 0 | 3 |
| | ME625 | Energy, Ecology and Environment | NIL | 3 | 0 | 0 | 3 |

*** PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS**


 Professor & Head
 Department of Mechanical Engineering
 Mrita Institute of Technology
 MESRA, BANCHI-835315

DEPARTMENT OF MECHANICAL ENGINEERING
OPEN ELECTIVES (OE)*
OFFERED FOR LEVEL 5-6

| OE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|-------------------|-----------------|-------------------------------|--|----------|----------|----------|----------|
| 5 | ME582 | Design Methodology | NIL | 3 | 0 | 0 | 3 |
| | ME583 | Renewable Source of Energy | NIL | 3 | 0 | 0 | 3 |
| | ME584 | Energy Management & Auditing | NIL | 3 | 0 | 0 | 3 |
| | ME585 | Industrial Robotics | NIL | 3 | 0 | 0 | 3 |
| | ME586 | Reliability in Design | NIL | 3 | 0 | 0 | 3 |

*** OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS**



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

PEO 1: To develop capability to understand the fundamentals of Science and Energy Technology for analyzing the engineering problems with futuristic approach.

PEO 2: To foster a confident and competent post graduate capable to solve real life practical engineering problems fulfilling the obligation towards society.

PEO 3: To inculcate an attitude for identifying and undertaking developmental work both in industry as well as in academic environment with emphasis on continuous learning enabling to excel in competitive participations at global level.

PEO 4: To nurture and nourish effective communication and interpersonal skill to work in a team with a sense of ethics and moral responsibility for achieving goal.

PROGRAM OUTCOMES (POs)

M. Tech. in Mechanical Engineering (ENERGY TECHNOLOGY)

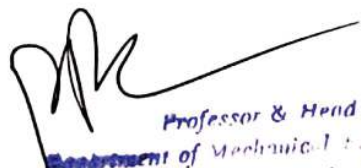
PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Apply software skills in the field of modeling, analysis and system simulation such as MATLAB, ANSY- CFX, Fluent for performance evaluation and optimization of nonrenewable/ renewable energy systems like bio, wind, solar and hybrid systems.

PO5: Recognize the need for lifelong learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME541

Course title: Renewable Sources of Energy

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Create awareness about sources of energy and able to estimate how long the available conventional fuel reserves will last. |
| 2. | Learn the fundamental concepts about solar energy systems and devices. |
| 3. | Design wind turbine blades and know about applications of wind energy for water pumping and electricity generation. |
| 4. | Understand the working of OTEC system and different possible ways of extracting energy from ocean, know about Biomass energy, mini-micro hydro systems and geothermal energy system. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand of renewable and non-renewable sources of energy |
| CO2. | Gain knowledge about working principle of various solar energy systems |
| CO3. | Understand the application of wind energy and wind energy conversion system. |
| CO4. | Develop capability to do basic design of bio gas plant. |
| CO5. | Understand the applications of different renewable energy sources like ocean thermal, hydro, geothermal energy etc. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: INTRODUCTION TO ENERGY STUDIES

Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources , Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario. (8L)

Module 2: SOLAR ENERGY

Introduction, Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system , Solar Cookers , Solar driers, Solar Still, Solar Furnaces, Solar Greenhouse. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies. (8L)

Module 3: WIND ENERGY

Introduction, History of Wind Energy, Wind Energy Scenario of World and India. Basic principles of Wind Energy Conversion Systems (WECS), Types and Classification of WECS, Parts of WECS, Power, torque and speed characteristics, Electrical Power Output and Capacity Factor of WECS, Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Site selection criteria, Wind farm, Wind rose diagram. (8L)

Module 4: BIOMASS ENERGY

Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to Energy Conversion, Biomass Gasification, Types and application of gasifier, Biomass to Ethanol Production, Biogas production from waste biomass, Types of biogas plants, Factors affecting biogas generation, Energy plantation, Environmental impacts and benefits, Future role of biomass , Biomass programs in India. (8L)

Module 5: HYDRO POWER AND OTHER RENEWABLE ENERGY SOURCES

Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts. Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants. Ocean Thermal Energy: Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC

4


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME542

Course title: Fuel Technology

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Present a comprehensive and rigorous study of fuel while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as coal, petroleum and to prepare the students to effectively use fuel in the practice of engineering. |
| 3. | Develop an intuitive understanding of fuel technology by emphasizing the physics and physical arguments. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Classify various type of fuel. |
| CO2. | Analyze coal from technical prospective. |
| CO3. | Examine the liquid fuel extraction methods. |
| CO4. | Explain the production methodology of gaseous fuels |
| CO5. | Analyse various nuclear fuels. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835213

SYLLABUS

Module 1: INTRODUCTION TO FUEL

Different fuel energy resources, it's Indian and global perspective, Classification of Solid, liquid and gaseous fuels, Combustion appliances for solid, liquid and gaseous fuels (8L)

Module 2: ORIGIN AND FORMATION OF COAL

Different theories on coal formation, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Fundamentals of coal combustion, combustion stoichiometry, Flue gas composition, Fundamentals of coal gasification, producer gas, water gas. (8L)

Module 3: EXTRACTION OF LIQUID FUELS

Petroleum and its derived products, Petroleum refining processes, Interconversion of fuels, Liquid fuel resources, world and Indian statistics, methods for characterization of crude oil and its products, refinery operations, testing of liquid fuels, industrial process design, utilization of petroleum products, synthetic liquid fuels. (8L)

Module 4: PRODUCTION OF GASEOUS FUELS

Natural gases and its derivatives, sources, potential, Gas hydrates Different types of gaseous fuels and its resources and their characteristics, principles of manufacturing of gaseous fuels from coal and oil, kinetics and mechanism of gasification, production of industrial fuel gases, rich gases such as SNG, purification, storage and transportation of gaseous fuels. (8L)

Module 5: NUCLEAR FUELS

Oxide fuel, Metal fuel, Ceramic fuel, liquid fuel, Refused-derived fuel, Bio-fuels: Biomass, Algae, biodiesel, Alcohol Fuels: Methanol, Ethanol, Butanol, Propane, etc. (8L)

Text Books

1. J.G. Speight and B. Ozum, Petroleum Refining Process, CRC Press, 2009.
2. J. G. Speight, The Chemistry and Technology of Coal, CRC Press, 2013.

Reference Books

1. F. Peter, Fuels and Fuel Technology, Wheaton & Co. Ltd., 1st edition, 1965.
2. S. Sarkar, Fuels and Combustion, Orient Longman, 2nd edition, 1990.
3. J. G. Speight, The chemistry & Technology of Petroleum, 4th edition, CRC Press, 2006.

COURSE INFORMATION SHEET

Course code: ME543

Course title: Energy Conversion System

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P:0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Critically examine the technology of energy systems that will be acceptable in a world faced with global warming, local pollution, and declining supplies of oil. |
| 2. | Focus on renewable energy sources and other non-carbon/reduced-carbon emitting sources. |
| 3. | Analyse both the devices and the overall systems are analyzed. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Analyze the solar thermal conversion system. |
| CO2. | Evaluate the solar thermal conversion systems for high temperature applications. |
| CO3. | Analyze the Photovoltaic & Bio-Energy Conversion Systems |
| CO4. | Design the Fuel cells. |
| CO5. | Examine various Electric Energy Conversion Systems. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: SOLAR THERMAL CONVERSION SYSTEM

Relevance of solar thermal power generation; Components of solar thermal power plant, Design and performance, characteristics of different solar concentrator types suitable for thermal power generation. (8L)

Module 2: SOLAR THERMAL CONVERSION SYSTEM FOR HIGH TEMPERATURE APPLICATIONS

Types of solar thermal conversion system used in high temperature application, Tracking of solar concentrators; performance characterization of solar concentrators both line focus and point focus, Comparative analysis of the both mode focus system, Optical design and concentration characteristics of line and point focus based system. (8L)

Module 3: THERMAL ENERGY CONVERSION & BIO-ENERGY CONVERSION SYSTEMS:

Thermo-electric generator, Concepts and design considerations of MHD generators, Cycle analysis of MHD systems, Thermionic power conversion and plasma diodes, Thermo chemical Conversion. Bio-energy conversion, bio methanation technology, Thermo chemical conversions. (8L)

Module 4: FUEL CELL TECHNOLOGY

Overview of fuel cells, Fuel cell thermodynamics, fuel cell efficiency, Fuel cell characterization, Fuel cell modelling and system integration, Balance of plant, Hydrogen production from renewable sources and storage, life cycle analysis of fuel cells. (8L)

Module 5: ELECTRIC ENERGY CONVERSION SYSTEM

Generation of electricity using different sources, Transmission and distribution losses, AC to DC and DC to AC conversions, Electric motors: Types, losses, efficiency, Lightning systems, Diesel generating systems. (8L)

Text Books

1. S. S. L. Chang, Energy Conversion, Prentice Hall, 1963.
2. S. W. Angrist, Direct Energy Conversion, Pearson, 1982.
3. R. J. Rosa, Magneto hydrodynamic Energy Conversion, Springer, 1987.
4. V. S. Bagotsky, Fuel Cell Problems and Solutions, John Wiley & Sons, 2009.

Reference Books

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970
2. Green M.A., Solar Cells, Prentice-Hall, Englewood Cliffs, 1982

COURSE INFORMATION SHEET

Course code: ME544

Course title: Wind Energy

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

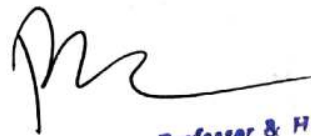
This course enables the students to:

| | |
|----|---|
| 1. | Understand the technologies that are used to harness the power of the wind. |
| 2. | Develop an intuitive understanding of wind turbine design criterion and its conversion system. |
| 3. | Discuss the positive and negative aspects of wind energy in relation to natural and human aspects of the environment. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Explain the existing wind energy potential. |
| CO2. | Analyze the various aerodynamic loads and its design criterion on wind turbine system. |
| CO3. | Describe the existing Wind Energy Conversion System. |
| CO4. | Analyze the control mechanism of wind turbine. |
| CO5. | Understand the application of wind energy with case studies and its environmental impacts. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: BASICS OF WIND ENERGY TECHNOLOGY

Wind statistics- Measurements and data Presentation, Historical developments, latest developments, state of art of wind energy technology, turbine rating, economic analysis of wind turbine, Indian scenario and worldwide developments, present status and future trends. Wind turbine aerodynamics. (8L)

Module 2: CHARACTERISTICS OF WIND ENERGY

Nature of atmospheric winds- Wind resource characteristics and assessment– Anemometry, speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography. effect of Reynolds's number, actuator disc, Betz coefficient, design of wind turbine blade, effect of stall and blade tip speed ratio and coefficient of torque. (8L)

Module 3: WIND ENERGY CONVERSION SYSTEM (WECS)

Rotor Selection, Annual Energy Output, HAWT, VAWT, Rotor Design Considerations- Number of Blades, Blade Profile -2/3 Blades and Teetering, Coning- Upwind/Downwind, Power Regulation, Yaw System- Tower, Synchronous and Asynchronous Generators and Loads, Integration of Wind Energy Converters to Electrical Networks, Inverters- Testing of WECS, WECS Control System - Requirements and Strategies. (8L)

Module 4: CONTROL MECHANISMS

Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism. Wind turbine dynamics with DC and AC generators: induction and synchronous generators, variable speed operation, effect of wind turbulence. Case study of design of wind mill. (8L)

Module 5: WIND ENERGY APPLICATION

Wind pumps - Performance analysis, design concept and testing, Principle of WEG- Stand alone, grid connected and hybrid applications of WECS, Economics of wind energy utilization, Wind energy in India- Case studies, environmental impacts of wind farms. (8L)

Text Books

1. Steve Parker, "Wind power", Gareth Stevens Publishing, 2004.
2. Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
3. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.

COURSE INFORMATION SHEET

Course code: ME545

Course title: Solar Passive Architecture

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Present a comprehensive and rigorous study of Solar passive architecture while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as solar passive architecture and to prepare the students to effectively use solar passive architecture in the practice of engineering. |
| 3. | Develop an intuitive understanding of fuel technology by emphasizing the physics and physical arguments. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Outline the need of solar passive architecture. |
| CO2. | Explain the passive solar heating of buildings |
| CO3. | Discuss the passive solar cooling of the building |
| CO4. | Explain the Climate And Human Thermal Comfort |
| CO5. | Point out the building rating systems |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: INTRODUCTION

Need for passive architecture - Building form and functions – General aspects of solar passive heating and cooling of buildings – Thumb rules - Thermal comfort – Sun's motion - Building orientation and design – Heat transfer in buildings. (8L)

Module 2: PASSIVE SOLAR HEATING OF BUILDINGS

Direct gain – Indirect gain – Isolated gain - Passive heating concept - Thermal modeling of passive concepts – Thermal storage wall and roof – Sunspace – Prediction of heating loads in a building. (8L)

Module 3: PASSIVE COOLING OF BUILDINGS

Passive cooling concept - Solarium Passive cooling - Ventilation cooling - Nocturnal radiation cooling -Evaporative cooling - Roof surface evaporative cooling (RSEC) - Direct evaporative cooling using drip-type (desert) coolers – Radiation cooling - Earth coupling - Basic principles and systems. (8L)

Module 4.: CLIMATE AND HUMAN THERMAL COMFORT

Factors affecting climate - Climatic zones and their characteristics - Urban climate - Microclimate - Implications of climate on building design - Principles of energy conscious design - Building materials - Embodied energy of building materials - Alternative building materials (8L)

Module 5: BUILDING RATING SYSTEMS

Zero energy building concept and rating systems - Energy conservation building codes – Energy management of buildings – Green globe assessment Standards –BREEAM – CASBEE – Green star–Review of CDM Techniques - GRIHA and others (8L)

Text Books

1. Jan F. Kreider, The solar heating design process: active and passive systems, McGraw-Hill, 2007.
2. David A. Bainbridge, Ken Haggard, Kenneth L. Haggard, Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting, and More Using Natural Flows, Chelsea Green Publishing, 2011.
3. N.K. Bansal, G. Hauser, G. Minke. Passive Building Design: A Handbook of Natural Climatic Control. Elsevier Science. 1994.

Reference Books

1. HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010.
2. Tom P. Hough, Trends in Solar Energy Research, Nova Publishers, 2006.
3. Source Wikipedia, Books Llc, Solar Architecture: Passive Solar Building Design,

COURSE INFORMATION SHEET

Course code: ME546
Course title: Hydrogen Energy System
Pre-requisite(s): Nil
Co-requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Provide comprehensive and logical knowledge of hydrogen production, storage and utilization. |
| 2. | Develop skills in critical thinking and reasoning about issues associated with hydrogen fuel. |
| 3. | Understand hydrogen generation techniques and hydrogen economy. |
| 4. | Emphasize on the hydrogen energy safety techniques. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate the basic concepts of Hydrogen Energy. |
| CO2. | Illustrate the various hydrogen storage & transportation techniques. |
| CO3. | Examine the usage of Hydrogen Energy in various day to day applications. |
| CO4. | Usage of Hydrogen Energy in Advanced Applications. |
| CO5. | Analyze the safety issues related to use of hydrogen as fuel. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
Mesra, RANCHI-835215

SYLLABUS

Module 1: HYDROGEN PROPERTIES AND PRODUCTION PROCESSES

Physical and Chemical properties of hydrogen. Production from fossil fuels, Steam, water. Advanced production methods- production using nuclear energy and renewable, photochemical, photocatalytic, hybrid, etc. (8L)

Module 2: HYDROGEN STORAGE, HANDLING & TRANSPORTATION

Storage Technologies, Compressed hydrogen, Cryo-adsorption, Liquid hydrogen, Slush hydrogen, Underground hydrogen storage, Hydrogen tank, Automotive Onboard hydrogen storage, Hydrogen transportation methods, Challenges associated with hydrogen transport. (8L)

Module 3: HYDROGEN UTILIZATION

I.C. Engines, power plant, gas turbines, hydrogen burners, domestic and marine applications, durability studies, field trials and effect on environment, Current use scenario, eco-friendly nature. (8L)

Module 4: ADVANCED TECHNOLOGIES

Fuel cells, Hydrogen Vehicles, Hydrogen Powered Cars, Hydrogen Powered planes, Hydrogen powered rockets. (8L)

Module 5: HYDROGEN SAFETY

History of accident, Safety barrier diagram, Hydrogen safety codes and standards, Hydrogen sensing, risk analysis, safety in handling, safety management. Hazard spotting and evaluation. (8L)

Text Books

1. M. Ball and M. Wietschel, The Hydrogen Economy Opportunities and Challenges, Cambridge University Press, 2009
2. Ram B. Gupta, Hydrogen Fuel: Production, Transport, and Storage, CRC Press-Taylor & Francis, 2008
3. Peschka, Walter, Liquid hydrogen: fuel of the future, Springer-Verlag Wien, 1992.
4. Kenneth D., Jr.; Edeskuty, F. J. Williamson, Recent Developments in Hydrogen Technology, CRC Press, 1986.

Reference Books

1. M.K.G. Babu, K.A. Subramanian, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, 2013
2. Kazunari Sasaki et al. Hydrogen Energy Engineering: A Japanese Perspective- Springer, 2016

COURSE INFORMATION SHEET

Course code: ME547
Course title: Energy Laboratory I
Pre-requisite(s): Nil
Co-requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Expose students to the real working environment and get acquainted with the literature available of the various research challenges in the field of Energy Technology. |
| 2. | Promote and develop presentation skills and import a knowledgeable society. |
| 3. | Set the stage for future recruitment by potential employers. |

Course Outcomes

At the end of this course, a student should be able to:

| | |
|------|--|
| CO1. | Locate the I-V and P-V characteristic with variation in temperature and radiation under series and parallel combination. |
| CO2. | Predicting the effect of shading and using of bypass and blocking diode. |
| CO3. | Calculate the work out and power flow in the standalone PV system with various combinations. |
| CO4. | Deducing the discharge and charge characteristic of battery. |
| CO5. | Perform case studies of solar system establishments. |

List of Experiments

Experiment 1: To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level.

Experiment 2: To demonstrate the I-V and P-V characteristics of series and parallel combination of PV modules.

Experiment 3: To show the effect of variation in tilt angle on PV module power.

Experiment 4: To demonstrate the effect of shading on module output power.

Experiment 5: To demonstrate the working of diode as Bypass diode and blocking diode.

Experiment 6: Workout power flow calculations of stand-alone PV system of DC load with battery.

Experiment 7: Workout power flow calculations of stand-alone PV system of AC load with battery.

Experiment 8: Workout power flow calculations of stand-alone PV system of DC and AC load with battery.

Experiment 9: To draw the charging and discharging characteristics of battery.

Experiment 10: Comparative performance study solar plan at BIT Mesra.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

COURSE INFORMATION SHEET

Course code: ME548
Course title: Computational Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Provide exposure to modern computational techniques in fluid dynamics and heat transfer. |
| 2. | Apply computational methods for solving complex engineering problems. |
| 3. | Set the stage for future recruitment by potential employers in the field of simulation. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Recognize the importance of CFD in Heat and Fluid flow. |
| CO2. | Analyse forced convection heat transfer coefficient over regular bodies like cylinder. |
| CO3. | Solve computational problems related to fluid flows and heat transfer. |
| CO4. | Recognize how to handle different boundary conditions. |
| CO5. | Analyse how to apply different prebuilt Models in CFD. |

List of Experiments

- Experiment 1:** To simulate a Simple Conduction Problem.
Experiment 2: To simulate a Mixed Boundary Problem (Conduction/ Convection/ Insulated).
Experiment 3: To simulate a Transient Thermal Conduction Problem.
Experiment 4: To do a Coupled Structural/Thermal Analysis.
Experiment 5: To simulate a Conjugate Heat Transfer Problem.
Experiment 6: To prepare a Computational Thermal Model of fluid flow in an elbow.
Experiment 7: To simulate fluid flow across a staggered uniformly-spaced tube arrangement.
Experiment 8: Understanding the simulation using Surface-to-Surface (S2S) Radiation Model.

COURSE INFORMATION SHEET

Course code: EE597

Course title: Power Generation, Transmission and Distribution

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Expose students to the 'real' working environment in the field of power generation, transmission and distribution field. |
| 2. | Promote and develop effective state of art in the field of power generation, transmission and distribution field. |
| 3. | Set the stage for future recruitment by potential employers |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Analyze the basic concepts of energy generation. |
| CO2. | Understand the Interface Auxiliaries of power system. |
| CO3. | Contrast high voltage A.C. transmission |
| CO4. | Contrast high voltage D.C. transmission |
| CO5. | Able to design Distribution network |

SYLLABUS

Module 1: GENERATION

Synchronous generator operation, Power angle characteristics and the infinite bus concept, dynamic analysis and modeling of synchronous machines, Excitations systems, Prime mover governing systems, Automatic generation control (8L)

Module 2: INTERFACE AUXILIARIES

Power system stabilizer, Artificial intelligent controls, Power quality (8L)

Module 3: AC TRANSMISSION (HVAC)

Overhead and cables, Transmission line equations, Regulation and transmission line losses, Reactive power compensation, Flexible AC transmission (8L)

Module 4: HVDC TRANSMISSION

HVDC converters, advantages and economic considerations, converter control characteristics, analysis of HVDC link performance, Multi-terminal DC system, HVDC and FACTS (8L)

Module 5: DISTRIBUTION

Distribution systems, conductor size, Kelvin's law, performance calculations and analysis, Distribution inside and commercial buildings entrance terminology, Substation and feeder circuit design considerations, distribution automation, Futuristic power generation (8L)

Text Books

1. A.J.Wood and B.F.Wollenberg, Power Generation, Operation, and Control. John Wiley & Sons, 2003.
2. P.M.Anderson and A.A Fouad, Power System Control and Stability, Wiley-IEEE Press, 2002

Reference Books

1. O.I.Elegrad, Electric Energy System Theory: An Introduction, T.M.H. Edition, 1982.
2. C.K.Kim, V.K.Sood, G.S.Jang, J.Lim, J.Lee, HVDC Transmission: Power Conversion Applications in Power Systems, Wiley-IEEE Press, 2009.
3. T.Gonen, Electric Power Transmission System Engineering Analysis and Design, CRC Press, 2009
4. P.Kundur, Power system stability and control, McGraw-Hill, 1994.

COURSE INFORMATION SHEET

Course code: ME553

Course title: Economics and Planning of Energy Systems

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 4 L: 3 T: 1 P: 0

Class schedule per week: 04

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Undertake financial feasibility evaluation studies of energy technologies and to discuss various issues involved in economics and techniques used in energy planning. |
| 2. | Provide relevant inputs on energy-economy-environment interaction related policy studies. |
| 3. | Should have the ability to understand the economies of different energy systems. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Outline the concept of energy and able to compare microeconomic and macroeconomic theories. |
| CO2. | Develop an understanding of the concepts of various interest rate methods and implement the suitable one. |
| CO3. | Analyze the best economic model from various available alternatives. |
| CO4. | Implement energy and development in energy policy and planning. |
| CO5. | Analyse economies of different energy system. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: INTRODUCTION

Overview of world energy scenario, Overview of India's energy scenario, Economics of various energy conservation schemes. Total energy systems, Basic economic problems. Nature of economics, Positive and normative economics, Micro and macroeconomics, Basic concepts in economics. The role of the state in economic activity, New economic policy in India, Energy economics and its relations with other branches. (8L)

Module 2: ENERGY ECONOMICS

Energy economics - Simple payback period, Discount rate, internal rate of return, Time value of money, IRR, NPV, Life cycle costing, Cost of saved energy, Cost of energy generated, Examples from energy generation and conservation. Energy chain, Primary energy analysis, Life cycle assessment, Net energy analysis. (8L)

Module 3: ECONOMICS AND PLANNING

Basics of engineering economics, Relevance of financial and economic feasibility, Evaluation of energy technologies and systems, Financial evaluation of energy technologies, Social cost benefit analysis, Methods for evaluation of tangible alternatives, Replacement analysis, Project feasibility analysis, Marketing feasibility, Technical feasibility, Financial feasibility, Risk analysis and decision trees. (8L)

Module 4: ENERGY AND DEVELOPMENT

Energy and development, Role of energy in economic development, Energy intensity and energy elasticity, National and International comparison, Low, Middle, and High income economies, Role of International institutions – OPEC, OAPEC, IEA, and World Bank. Energy demand analysis and forecasting, Energy investment planning and project formulation, Energy pricing. Policy, planning and implications of energy. Financing of energy systems, Energy policy related acts and regulations. (8L)

Module 5: ECONOMICS OF ENERGY SYSTEM

Introduction to economics of energy system, Economics of solar energy systems, Economics of biomass energy systems, Economics of wind energy systems, Economics of ocean energy systems, Economics of geothermal energy systems, Economics of Small-Mini-Micro hydro system, Economics of hydrogen energy systems. (8L)

Text Books

1. M. Kleinpeter, Energy Planning and Policy, John Wiley & sons.
2. C.S.Park, Contemporary Engineering Economics, Prentice Hall Inc.
3. G.D. Ray, Non-Conventional Energy Sources, Khanna Publications.

COURSE INFORMATION SHEET

Course code: ME554

Course title: Energy Management and Auditing

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 4 **L:** 3 **T:** 1 **P:** 0

Class schedule per week: 04

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Present a problem oriented introductory knowledge of Energy management and energy audit. |
| 2. | Understand basic concepts of Energy conservation. |
| 3. | Understand Energy efficiency and cost benefit. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Outline of energy management system and related policies and Acts. |
| CO2. | Apply the concept of Energy Management in energy related issues |
| CO3. | Work with energy management system and energy audit of whole system. |
| CO4. | Analyse energy conservation related to environmental issues |
| CO5. | Carry out Auditing of energy equipments and prepare energy flow diagrams and energy audit report |

SYLLABUS

Module 1: INTRODUCTION

Energy and Sources of energy, Energy consumption and GDP, Costs of exploration and utilization of resources, Energy pricing, Energy demand and supply, National energy plan, Need for Energy Policy, National and State level Energy Policies. Basic concepts of Energy Conservation and its importance, Energy Strategy for the Future, The Energy Conservation Act and its Features, Energy conservation in household, Transportation, Agricultural, Service and Industrial sectors, Lighting, HVAC Systems. (8L)

Module 2: ENERGY MANAGEMENT

History of Energy Management, Definition and Objective of Energy Management and its importance. Need of energy management, General Principles of Energy Management, Energy Management Skills, and Energy Management Strategy. Energy Management Approach. Understanding Energy Costs, Benchmarking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution. Organizing, Initiating and Managing an energy management program. Roles, responsibilities and accountability of Energy Managers. (8L)

Module 3: ENERGY AUDIT

Energy audit concepts, Definition, Need and Types of energy audit. Energy Audit Approach and Methodology. Systematic procedure for technical audit. Understanding energy audit costs, Benchmarking and Energy Performance. Energy audit based on First law and Second law of thermodynamics, Mass and Energy balances, Availability analysis, Evaluation of energy conserving opportunities, Economic analysis and life cycle costing. Duties and responsibilities of energy auditors. Energy audit instruments and their usage for auditing. Report-writing, preparations and presentations of energy audit reports. (8L)

Module 4: ENERGY CONSERVATION AND ENVIRONMENT

Energy conservation areas, Energy transmission and storage, Plant Lecture wise energy optimization Models, Data base for energy management, Energy conservation through controls, Computer aided energy management, Program organization and methodology. Energy environment interaction, Environmental issues, Global Warming, Climate Change Problem and Response, Carbon dioxide emissions, Depletion of ozone layer, Governments Regulations, Energy Economy interaction. Energy Conservation in Buildings, Energy Efficiency Ratings & ECBC (Energy Conservation Building Code) (8L)

Module 5: CASE STUDIES

Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.) (8L)

COURSE INFORMATION SHEET

Course code: ME555

Course title: Energy Storage Technology

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Present a comprehensive and rigorous study of energy storage technology while retaining an engineering perspective. |
| 2. | Lay the groundwork for subsequent studies in such fields as thermal energy storage, electrochemical energy storage, magnetic and electric energy storage systems and to prepare the students to effectively use energy storage in the practice of engineering. |
| 3. | Develop an intuitive understanding of energy storage technology by emphasizing the physics and physical arguments. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Outline the various type of energy storage system. |
| CO2. | Analyze the electrochemical energy storage systems. |
| CO3. | Examine the magnetic and electric energy storage systems. |
| CO4. | Explain the sensible heat thermal energy storage |
| CO5. | Estimation of latent heat thermal energy storage. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: ENERGY STORAGE

Need of energy storage, Different modes of Energy Storage. Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage. (8L)

Module 2: ELECTROCHEMICAL ENERGY STORAGE SYSTEMS

Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon Nano-tubes in electrodes. (8L)

Module 3: MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS

Superconducting Magnet Energy Storage (SMES) systems; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon Nano-tube. (8L)

Module 4: SENSIBLE HEAT THERMAL ENERGY STORAGE

SHS mediums; Stratified storage systems; Rock-bed storage systems; Thermal storage in buildings; Earth storage; Energy storage in aquifers; Heat storage in SHS systems; Aquifers storage. (8L)

Module 5: LATENT HEAT THERMAL ENERGY STORAGE

Phase Change Materials (PCMs); Selection criteria of PCMs; Stefan problem; Solar thermal LHTES systems; Energy conservation through LHTES systems; LHTES systems in refrigeration and air-conditioning systems; Enthalpy formulation; Numerical heat transfer in melting and freezing process. (8L)

Text Books

1. Robert, Huggins. Energy Storage: Fundamentals, Materials and Applications. Springer Press 2016.
2. Richard Baxter. Energy storage. PennWell Corp. (September 10, 2005). Elsevier

Reference Books

1. Ahmed Zobia, Energy storage: technologies and applications. Intech Open, 2014
2. David Elliott. Energy Storage Systems. IOP Publishing, Bristol, UK 2014

COURSE INFORMATION SHEET

Course code: ME556

Course title: Heat and Mass Transfer

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Investigate cases of heat and mass transfer process in terms of similarity parameters. |
| 2. | Study various applications, mathematical relations of heat and mass transfer. |
| 3. | Analyze heat and mass transfer and do thermal design at industry level. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Extend the similarity concept in velocity and thermal boundary layer for isothermal and non-isothermal cases. |
| CO2. | Examine the Analogy between flow field and heat transfer. |
| CO3. | Apply the boundary layer concept in pipe and duct flow. |
| CO4. | Formulate and estimate free convection heat transfer. |
| CO5. | Explain and estimate mass transfer. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Similarity concepts in heat transfer for laminar and turbulent flows; Boundary layer equations; Boundary layer integral equation; similarity and integral solutions of flow over isothermal and non-isothermal flat plate, Numerical solutions. (9L)

Module 2:

Turbulent Flows: governing equations, mixing length turbulence models, analogy solutions for heat transfer in turbulent flows, near walls region, transition from laminar to turbulent flow, analogy solution for boundary layer flows, numerical solutions., viscous dissipation effects. (7L)

Module 3:

Fully developed pipe and plane duct flow under constant heat flux and constant wall temperature; Pipe flow with developing temperature field; Fully developed laminar flow in ducts with other cross-sectional shapes. (7L)

Module 4:

Concept of free convection for plate and cylinders at constant heat flux and constant wall temperature; free convection in finned surfaces and PCBs; free convection in plane enclosures and in concentric cylindrical enclosures. (8L)

Module 5:

Significant parameters in convective mass transfer, application of dimensional analysis to Mass Transfer, Analogies among mass, heat, and momentum transfer, Convective mass transfer correlations, Mass transfer between phases, Simultaneous heat and mass transfer. (9L)

Text Books

1. Heat and Mass Transfer, Y. A. Cengel and A. J. Ghajar, McGraw-Hill Education, 2014.
2. An Introduction to convective Heat Transfer Analysis, P. H. Oosthuizen and D. Naylor, 1999.

Reference Books

1. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, John Wiley & Sons, 2006.
2. Convective Heat and Mass Transfer, William M. Kays & Michael E Crawford, McGraw-Hill Science/Engineering/Math, 1993.
3. Principles of Heat Transfer, Frank Kreith and Mark S. Bohn, West Publishing Company, 1993.
4. Heat Exchange Design, D.Q. Kern, McGraw-Hill Book Co., Inc., New York, 1950.

COURSE INFORMATION SHEET

Course code: ME557

Course title: Integrated Energy System

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Expose students to the 'real' working environment in the field of Integrated Energy System. |
| 2. | Promote and develop effective state of art in the field of Integrated Energy System. |
| 3. | Set the stage for future recruitment by potential employers. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Analyze the fuel availability pattern and its usual demand pattern. |
| CO2. | Project the energy demands. |
| CO3. | Understand the potential of renewable energy sources. |
| CO4. | Design Integrated energy models of various energy sources. |
| CO5. | Understand the need of power quality. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
JESRA, RANCHI-835215

SYLLABUS

Module 1:

Pattern of fuel consumption: agricultural, domestic, industrial and community needs. (8L)

Module 2:

Projection of energy demands, Substitution of conventional sources by alternative sources and more efficient modern technologies. (8L)

Module 3:

Potential, availability as well as capacity of solar, wind, biogas, natural gas, forest produce, tidal, geothermal, mini-hydro and other modern applications. (8L)

Module 4:

Hybrid and integrated energy systems, Total energy concept and waste heat utilization, Energy modeling to optimize different systems. (8L)

Module 5:

Power Quality: voltage regulation, frequency matching, Synchroscope.

Application of Power electronics in the Integrated energy System: HVAC to HVDC, MPPT, converter, rectifier and inverter. (8L)

Text Books

1. Renewable Energy Sources for fuels and Electricity by Laurie Barrtom.
2. Wind-Diesel Systems by R. Hunter and G. Elliot, Cambridge University Press.

Reference Books

1. P.Kundur, Power system stability and control, McGraw-Hill, 1994.
2. Dragan Maksimovic, Robert Warren Erickson, Springer, 1997

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Programming based problems are not focused
POs met through Gaps in the Syllabus: PO3

Topics beyond syllabus/Advanced topics/Design:

Programming based numerical problems.
POs met through Topics beyond syllabus/Advanced topics/Design: PO3

COURSE INFORMATION SHEET

Course code: ME558

Course title: Energy Laboratory II

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Be aware of the immediate market opportunities and challenges in fuel cell systems, and the current state of the art. |
| 2. | Gain hands-on experience of different types of Solar Thermal Energy Systems. |
| 3. | Set the stage for future recruitment by potential employers. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Evaluate performance of fuel cells. |
| CO2. | Operate and maintain the existing fuel cell systems. |
| CO3. | Train personnel in the method and development of fuel cell technology. |
| CO4. | Calculate the various parameters in the inside solar water heater. |
| CO5. | Provide training in operation and maintenance of solar thermal energy equipment. |

List of Experiments

Experiment 1: Characteristics of fuel cell with the help of resistive load or DC-DC converter

Experiment 2: Output power variation of fuel cell with change in Hydrogen supply

Experiment 3: Evaluate Fuel cell system performance with only DC load connected to the charge controller with battery bank.

Experiment 4: Evaluate Fuel cell System performance with only AC load connected to the inverter with battery bank.

Experiment 5: Evaluation of U_L , F_R and η in thermosyphonic mode of flow with fixed input parameters.

Experiment 6: Evaluation of U_L , F_R and η and drawing of different curves in forced mode of flow at different flow rate.

Experiment 7: Evaluation of U_L , F_R and η in forced mode of flow at different radiation level
Maximum radiation level.

Experiment 8: Evaluation of U_L , F_R and η in thermosyphonic mode of flow with different wind speed.

Experiment 9: Evaluation of U_L , F_R and η and drawing different curves in forced mode of flow at different flow rate.

Experiment 10: Evaluation of U_L , F_R and η in forced mode of flow at different tilt angle.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

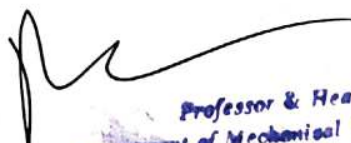
| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |


 Professor & Head
 Department of Mechanical Engineering
 Birsa Institute of Technology
 MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME600

Course title: Thesis Part I

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 8 L: T: P:

Class schedule per week:

Class: M.Tech.

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |

COURSE INFORMATION SHEET

Course code: ME639

Course title: Energy Simulation and Modelling

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Provide knowledge, understanding and application oriented skills on Energy, Modeling and Simulation. |
| 2. | Study the various model in details which are useful for energy planning. |
| 3. | Utilize the modeling techniques for simulating and helping in meeting electricity demand with minimum wastage. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the various energy policies. |
| CO2. | Analyze the different Input-Output and Econometric Models. |
| CO3. | Solve problems on various Optimization Models. |
| CO4. | Analyze the Process Analysis Models. |
| CO5. | Review the System Dynamic and Other Simulation Models |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: INTRODUCTION

Energy policy analysis; need for energy modeling; classification of energy models; types of computer based tools for energy planning; national and rural energy planning; sectorial energy planning. (8L)

Module 2: INPUT-OUTPUT AND ECONOMETRIC MODELS

Types and Characteristics of I-O models; use of I-O models; IO transaction tables; method of estimation and sources of data; mathematical expression on the methodology of construction of I-O tables; case studies. Statistical estimation techniques; time series; regression analysis; advantages and limitations of econometric models; elastic ties of energy demand; case studies. (8L)

Module 3: OPTIMIZATION MODELS

Linear and non-linear optimization models; advantage and limitation of optimization models; case studies of linear optimization models for national and rural energy planning (8L)

Module 4: PROCESS ANALYSIS MODELS

End-use models; process analysis models for industrial, domestic and transport energy conservation; advantage and limitations of process analysis models; case studies. (8L)

Module 5: SYSTEM DYNAMIC AND OTHER SIMULATION MODELS

Concept of closed system; causal loop diagram; flow diagram and system equations; dynamic behavior of energy systems; advantages and limitations of simulation models; case studies. (8L)

Text Books

1. J.P. Weyant & T. A. Kuczmowski "Engineering- Economy Modeling: Energy Systems" Energy-The International Issue (Special issue an energy modeling), Pergaman Press. Vol. 15, No. ¾ PP 145-715, 1990.
2. Richard de Nenfville, " Applied Systems Analysis" Mc Graw Hill International Eds. 1990.

Reference Books

1. J. W. Forrester, "Principles of Systems" MIT Press, 1982.
2. Rene Codoni, Hi- Chun Park, K.V. Ramani, " Integrated Energy Planning: A Manual" Volume on policy planning, Asian & Pacific Development Center, Kuala Lumpur 1985.

COURSE INFORMATION SHEET

Course code: ME622

Course title: Bioconversion & Processing of Waste

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Give an idea about different biomass and other solid waste materials as energy source. |
| 2. | Have comprehensive knowledge of how wastes are utilized for recovery of value. |
| 3. | Study in detail the processing and utilization of biomass for recovery of energy and other valuable products. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the basics of biomass. |
| CO2. | Analyze the different biological conversion methods. |
| CO3. | Examine the other Conversion methods. |
| CO4. | Evaluate the various waste processing techniques. |
| CO5. | Design the biogas digester. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: INTRODUCTION

Biomass and solid wastes, Broad classification, Sources of Bio mass, Production of biomass, biomass yield comparison, photosynthesis, world scenario, Environmental effects.

(8L)

Module 2: BIOLOGICAL CONVERSION

Biodegradation and biodegradability of substrate - Biochemistry and process parameters of biomethanation - Biomethanation Process - Bioconversion of substrates into alcohol - Methanol & ethanol Production - Organic acids – Solvents - Amino acids - Antibiotics etc, agro chemical conversion.

(8L)

Module 3: OTHER CONVERSIONS

Thermo chemical conversion of biomass, conversion to solid, liquid and gaseous fuels, pyrolysis, gasification, combustion, Enzymatic Fermentation, Gas/liquid Fermentation, Acid hydrolysis and hydrogenation.

(8L)

Module 4: WASTE PROCESSING

Separation of components of solid wastes, handling and processing techniques, composting technique, recycling, Agro and forestry residues utilization through conversion routes, Use of biodegradable waste.

(8L)

Module 5: DESIGN AND ECONOMICS

Economics of biogas plant with their environmental and social impacts, Biogas digester types - Digester design and biogas utilization, Fuel conversion into electricity, Climate change Impact, case studies, Conversion of municipal waste into petrol.

(8L)

Text Books

1. S.Samir, R.Zaborsky, Biomass Conversion Processes for Energy and Fuels, New York, Plenum Press, 1981.
2. H.D.Joseph, P.Joseph, H.John, Solid Waste Management, New York, Van Nostrand, 1973.
3. Jianzhong Sun et al. Biological Conversion of Biomass for Fuels and Chemicals: Explorations from Natural Utilization Systems (Energy and Environment Series), RSC Publishing, 2013.

Reference Books

1. G.Tchobanoglous, H.Theisen, S.V.Tchobanoglous, G.Theisen, H.V.Samuel, Integrated Solid Waste management: Engineering Principles and Management issues, New York, McGraw Hill, 1993.

COURSE INFORMATION SHEET

Course code: ME623

Course title: Solar Photovoltaic System

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Introduce students to the various aspects of PV technologies. |
| 2. | Enable students to understand the working principle of Photovoltaic Solar Cells. |
| 3. | Make students familiar about the different solar cell technologies. |
| 4. | Emphasize about the different materials and recent advances in Solar PV technology. |
| 5. | Develop understanding of solar PV systems in power generation. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate the basic concepts of Photovoltaic Cells. |
| CO2. | Illustrate the working principles of Photovoltaic Solar Cells. |
| CO3. | Analyze the different Solar Cell Technologies. |
| CO4. | Compare the current research fields in Solar Photovoltaic. |
| CO5. | Design the Solar PV Systems. |


Professor & Head
Department of Mechanical Engineering
Birsa Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: FUNDAMENTALS OF PHOTOVOLTAIC CELLS

Solar cell working, General Types, Testing of Solar cells, Materials used for manufacturing, manufacturing processes involved for fabrication, Decreasing cost of PV cells, present scenario, Solar cells, modules, panels and systems. (8L)

Module 2: PHOTOVOLTAIC CELLS WORKING

Review of semiconductor physics and Operating principle, Design of solar cells-Cell parameters limits, Losses in solar cells, Solar cell design for high I_{sc} , V_{oc} and FF, PV device characterization. Factors affecting the efficiency of solar cell, Strategies to enhance the efficiency of solar cell. Environmental effects of Photovoltaic. (8L)

Module 3: SOLAR CELL TECHNOLOGIES

First, Second and Third Generation PV Silicon based technologies. Manufacturing processes (wafer, cell and module) for Solar cells. Concept of multi-junction or tandem cells, concentrating technologies, Optics for concentrators, PV-Tracking Requirements, High concentrator solar cells. (8L)

Module 4: RECENT ADVANCES

Emerging solar cell technologies (Organic PV, Hetero junction with intrinsic thin film – HIT - Quantum dots - Dye Sensitized Solar cell - Perovskite solar cells etc). (8L)

Module 5: PV MODULE AND PV SYSTEM APPLICATIONS

Solar PV system, Batteries for PV systems -DC to DC and DC to AC converters-charge controllers, stand alone, hybrid and grid connected system, Standalone PV systems (Lighting, Water Pumping etc.), Design methodology of PV off grid and grid connected systems, Load estimation and System Sizing, Design of roof top solar PV power plants. (8L)

Text Books

1. Mertens K. ,2013, Photovoltaics: Fundamentals, Technology and Practice, Wiley
2. Solanki C. S. ,2009, Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall India

Reference Books

1. Mukerjee A. K. and Thakur N. ,2011, Photovoltaic systems: analysis and design, PHI
2. V Barbec, V.Dyakonov, J. Parisi, N.S. Sariciftci, 2003, Organic photovoltaics: Concepts and realization, Springer Verlag
3. Tiwari G N, 2012, Solar Energy: Fundamentals, Design, Modelling and Application

COURSE INFORMATION SHEET

Course code: ME624

Course title: Nuclear Energy

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand the sources of energy and their contributions to the energy and power needs of the nation and the world. |
| 2. | Understand the special engineering challenges of using each of these sources of energy efficiently and environmentally effectively. |
| 3. | Develop an intuitive understanding of the economics behind the costs of the uses and applications of each of these forms of energy. |
| 4. | Understand the energy conversion systems for nuclear power plants, the advantages/disadvantages (including overall environmental effects) of each type of present plants. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Analyze the basic concepts of nuclear energy. |
| CO2. | Describe the interaction of neutrons with matter. |
| CO3. | Contrast between nuclear fusion and fission reactions. |
| CO4. | Application of reactor theory in power reactor. |
| CO5. | Point out the plasma concepts. |

SYLLABUS

Module 1: INTRODUCTION TO NUCLEAR ENERGY

Nuclear nomenclature, Binding energy and semi-empirical mass formula, Radioactive decay, fission and fusion energy, typical reactions, concepts of Binding Energy of a nuclear reaction, mass energy equivalence and conservation laws, nuclear stability and radioactive decay, radioactivity calculations, Health Hazards: radiation protection & shielding. (8L)

Module 2: INTERACTION OF NEUTRONS WITH MATTER

Compound nucleus formation, elastic and inelastic scattering, cross sections, energy loss in scattering collisions, polyenergetic neutrons, critical energy of fission, fission cross sections, fission products, fission neutrons, energy released in fission, γ -ray interaction with matter and energy deposition, fission fragments. (8L)

Module 3: NUCLEAR FUSION AND FISSION REACTIONS

Fusion reactions, reaction cross-sections, reaction rates, fusion power density, radiation losses, ideal fusion ignition, Ideal plasma confinement & Lawson criterion. The fission chain reaction, reactor fuels, conversion and breeding, the nuclear power resources, nuclear power plant & its components, power reactors and current status. (8L)

Module 4: REACTOR THEORY & PLASMA CONCEPTS

Neutron flux, Fick's law, continuity equation, diffusion equation, boundary conditions, solutions of the DE, group diffusion method, Neutron moderation (two group calculation), one group reactor equation and the slab reactor.

Saha equation, Coulomb scattering, radiation from plasma, transport phenomena, Plasma Confinement Schemes: Magnetic and inertial confinement, current status. (8L)

Module 5: NUCLEAR REACTOR

Classification of the nuclear reactor and its important Components. Pressurized water reactors (PWR), Boiling water reactors (BWR), Pressurized Heavy Water Reactor (PHWR), Reactor Bolshoy Moschnosti Kanalniy (High Power Channel Reactor) (RBMK), Gas-cooled reactor (GCR) and advanced gas-cooled reactor (AGR), Liquid-metal fast-breeder reactor (LMFBR), Pebble-bed reactors (PBR), Molten salt reactors, Aqueous Homogeneous Reactor (AHR) (8L)

Text Books

1. Nuclear energy by Redman, L.A. 1963, Oxford university press.
2. R.A. Gross, Fusion Energy, John Wiley & Sons Inc., 2008.

Reference Books

1. R. K., Taneja. Nuclear energy, Cyber Tech Publications New Delhi, 2009.

COURSE INFORMATION SHEET

Course code: ME625

Course title: Energy Ecology and Environment

Pre-requisite(s): Basic of Physics, Chemistry and Mathematics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Introduce the concept of energy, ecology and environment. |
| 2. | Lay groundwork for understanding the relationship between energy, ecology and environment. |
| 3. | Enable the student to understand the relation between energy and environment. |
| 4. | Emphasize on the factors that leads to degradation of environment. |
| 5. | Create awareness about the various environmental remediation techniques. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the relationship between Energy, Ecology and Environment. |
| CO2. | Classify the various energy sources. |
| CO3. | Analyze the connection between Energy and Environment. |
| CO4. | Examine the various Environment Degrading Factors. |
| CO5. | Choose proper Environment Remediation Techniques. |

SYLLABUS

Module 1: INTRODUCTION

Connection between energy and environment, Sun as energy source, solar radiation, Biological processes, photosynthesis, Synecology and Autecology. Effect of Population on Ecosystem, Community Ecosystem (wetland, terrestrial, marine), Food chains, Ecosystem theories, biogeochemical and water cycling, terrestrial carbon cycling, Environmental Nanotechnology. (8L)

Module 2: SOURCES OF ENERGY

Classification of energy sources, Renewable/Non-Renewable Sources, Advantages and Disadvantages of different energy sources, Utilization of different energy sources. Energy, Demand and cost Analysis. Recent advances in energy sector. (8L)

Module 3: ENERGY AND ENVIRONMENT

Environmental problems linked with harnessing of fossil fuels (coal, oil, natural gas), nuclear energy, hydropower, biomass, solar, geothermal, tidal, wind, Energy flow and nutrient cycling in ecosystems. (8L)

Module 4: ENVIRONMENTAL DEGRADATION

Primary and secondary pollutants, air, soil and water pollution, thermal pollution, radioactive pollution, effect of pollution on climate, Pollution sources, Biological effects of radiation, Acid rain, etc, methods and techniques to study effect of nanoparticles in the environment, Toxicity of the nanomaterial and its possible impacts in the environment. (8L)

Module 5: ENVIRONMENTAL REMEDIATION

Waste disposal, Toxic Waste handling, Transportation of fuels and waste, Recycling, Methods to control Nano-particle pollution, Regulations of Industry to control waste, Pollution Control boards (8L)

Text Books

1. G. M. Masters, W P Ela, Introduction to Environmental Engineering and Science, Prentice Hall, 3 rd Edition, 2007.
2. Richard Wilson, Energy, Ecology, and the Environment, Academic Press 1974.

Reference Books

1. D. Nevers, Air Pollution Control Engineering, McGraw Hill, 2001.
2. Nikhil Sharma et al., Air Pollution and Control, Energy Environment and Sustainability Springer, 2017
3. A. Mackenzie, A. S. Ball and S. Virdee, Instant Notes: Ecology, 2nd Edition, BIOS Scientific Publishers Ltd., 2001.

COURSE INFORMATION SHEET

Course code: ME627
Course title: Simulation Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: III/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve linear system of equations. |
| 2. | Apply numerical integration method. |
| 3. | Analyse nature of functions. |
| 4. | Apply Numerical Methods for differential equations. |
| 5. | Evaluate Characteristics of functions. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Evaluate the linear differential equations. |
| CO2. | Evaluate the nature of functions. |
| CO3. | Analyse the nature of differential equations. |
| CO4. | Perform comparative analysis of numerical methods. |
| CO5. | Perform comparative analysis of numerical integration methods. |

List of Experiments

Experiment 1: To solve linear system of equations using Gaussian elimination.

Experiment 2: To solve linear system of equations using Gauss siedel.

Experiment 3: To solve linear system of equations using Gauss Jordan.

Experiment 4: Numerical Integration using Trapezoidal rule and Simpson rule.

Experiment 5: Numerical Integration using Romberg Integration.


Experiment 6: Numerical Integration using Quadrature formula.

Experiment 7: Finding maxima, minima of multivariable functions.

Experiment 8: Using least square method for approximation of functions.

Experiment 9: Applying conjugate gradient method.

Experiment 10: Solving ODE's using numerical Methods.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME650

Course title: Thesis Part II

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 16 **L:** **T:** **P:**

Class schedule per week:

Class: M.Tech.

Semester / Level: IV/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

**DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI**

Courses of Studies for M.E. Programme in Design of Mechanical Equipments

| | L | T | P | C | |
|----------------------------------|---|-----------|----------|----------|-------------|
| I Semester | | | | | |
| (Theory courses) | | | | | |
| MME 1051 | Advanced Strength of Materials | 3 | - | - | 3 |
| MME 1053 | Dynamics of Machines | 3 | - | - | 3 |
| MMA 1103 | Advanced Mathematics | 3 | 1 | - | 4 |
| Elective- any one | | | | | |
| MME 1061 | Optimisation Methods in Engineering | 3 | - | - | 3 |
| MME 1063 | MATLAB: An Introduction with Application | | | | |
| MME 1065 | Advanced Computer Graphics | | | | |
| Breadth Subject (any one) | | | | | |
| | | 3 | | | 3 |
| Sessional: | | | | | |
| MME 1052 | Elective Course work | - | - | 2 | 2 |
| MME 1054 | Dynamics of Machine Laboratory | - | - | 2 | 2 |
| | Total | 15 | 1 | 4 | 20 |
| | | | | | |
| II Semester: | | | | | |
| (Theory courses) | | | | | |
| MME 2071 | Advanced Mechanical Engineering Design | 3 | - | - | 3 |
| MME 2073 | Computer Aided Design of Mechanical System | 3 | - | - | 3 |
| MME 2075 | Engineering Design Methodology | 3 | 1 | - | 4 |
| Elective – any one | | | | | |
| MME 2083 | Mechanics of Robotic Manipulator | 3 | - | - | 3 |
| MME 2085 | Reverse Engineering & Rapid Prototyping | | | | |
| MME 2087 | Mechanical Vibrations | | | | |
| Breadth Subject (any one) | | | | | |
| | | 3 | - | - | 3 |
| Sessional: | | | | | |
| MME 2072 | Advanced Mechanical Engineering Desig course work | - | - | 2 | 2 |
| MME 2074 | CAD Lab | - | - | 2 | 2 |
| | Total : | | | | 20.0 |
| | | | | | |
| III Semester: | Thesis | | | | 15 |
| IV Semester: | Thesis | | | | 20 |
| | | | | | |
| Grand Total | | | | | 75 |


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-832015

MME 1051 Advanced Strength of Materials

Module 1

Review of stress, strain, stress Ellipsoid, Mohr's circle for stress in three dimensions. (5L)

Module 2

Theory of Elastic Stability: Euler's column formula with various end conditions, Column with initial eccentricity and eccentric loads, Column with load through a fixed point. Effect of shear force on critical load. (5L)

Module 3

Theory of Elastic Stability: Buckling of columns by energy method, approximate calculation of critical load by energy method, Buckling of rings and circular tubes, , Buckling of rectangular plate uniformly compressed in one direction (5L)

Module 4

Theory of Plates: Bending of long rectangular plates to a cylindrical surface with different boundary conditions. Effect on stresses and deflection by small displacements of longitudinal edges in the plane of plate. (5L)

Module 5

Theory of Plates: Pure bending of plates, Principle curvatures, Relations between bending moment and curvatures, Bending of plates by distributed lateral loads, Combined bending and tension or compression of plates, Strain energy in buckling of plates. (5L)

Module 6

Theory of Shells: Deformation of shells without and with bending, Membrane theory, Symmetrical buckling of cylindrical shell under the action of uniform axial compression.(5L)

Module 7

Computer Implementation Aspects for Simple 1D and 2D Problems. (5L)

Text Books:

1. Structural stability of columns and plates by N. G. R. Iyengar
2. Fundamentals of structural stability by :George J. Simitses
3. Theory of Elastic stability by S. Timoshenko & G. H. Gere.

Professor & Head
Department of Mechanical Engineering
DIT Deemed to be University
DIT - Kirti Institute of Technology
MIESRA, RANCHI-832015

Professor & Head
Department of Mechanical Engineering
DIT Deemed to be University
DIT - Kirti Institute of Technology
MIESRA, RANCHI-832015

MME 1053: Dynamics of Machines

Module 1:

Free undamped longitudinal, transverse and torsional vibration of system having single degree of freedom, two degrees of freedom and multi degrees of freedom. (5L)

Module 2:

Vibrations of geared system, Free damped vibration, Forced vibration with periodic excitation, vibration isolation and transmissibility. (5L)

Module 3:

Inertia force determination and analysis of forces of reciprocating engine mechanism and four bar mechanism. (5L)

Module 4:

Turning moment diagrams for engines, Fluctuation of the crank shaft speed and method to limit the fluctuation. (5L)

Module 5:

Balancing of reciprocating masses, Partial and complete balance, Primary and secondary balance of multi cylinder in-line engines, in-line engines with identical reciprocating parts. (5L)

Module 6:

Balancing of radial engines, Dynamic balancing machine Cam profile determination for any given motion of the follower. (5L)

Module 7:

Dynamics of high speed cam systems, Analysis of cams of specified contours. Cam applications. (5L)

Text Books:

1. Theory of Vibrations with Applications – W. T. Thomson
2. Theory of Mechanical vibration – K.N. Tong
3. Dynamic Balancing of Rotating Machinery by Wilcon
4. Cams by Harold and Rothbart
5. Theory of Machines by Thomas Beven.


Professor & Head
Department of Mechanical Engineering
Birsa Institute of Technology
MESRA, RANCHI-835215

MME 1061:OPTIMIZATION METHOD IN ENGINEERING

Introduction to Optimum design of Mechanical Systems. Need of optimization of preliminary design by identification of design requirements and by use of appropriate design strategy. Introduction to detail design optimization by simulation, prototyping and optimum selection of configuration, materials and processes.

Mechanical System Design problem – economic political environment, issues of human safety and welfare, and professional ethics.

Optimum mechanical design concepts. Overview and application of optimization methods to machine elements and mechanical system design. Prototyping, simulation, and use of standards for detail design optimization. Optimum selection of material and processes in mechanical design using material selection charts and optimization.

Books:

1. S. S. Rao, *Optimization: Theory and Applications*, 2nd ed. Wiley Eastern.
2. K. Deb, *Optimization for Engineering Design-Algorithms and Examples*, Prentice-Hall India.
3. J. S. Arora, *Introduction to Optimum Design*, MCGraw-Hill.
4. G. V. Reklaitis, A. Ravindran and K. M. Ragsdell, *Engineering Optimization-Methods and Applications*, Wiley.
5. R. L. Fox, *Optimization Methods for Engineering Design*, Addison Wesley.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

MME 1063: MATLAB: An Introduction with Applications

| | |
|---|------|
| Module 1: Matlab Basics | (5L) |
| Module 2: Numerical Methods | (5L) |
| Module 3: Optimizations | (5L) |
| Module 4: Direct Numerical Integration Methods Methods | (5L) |
| Module 5: Engineering Mechanics | (5L) |
| Module 6: Mechanical Vibrations | (5L) |
| Module 7: Variational Principles, Hamilton's Principles | (5L) |

Text Books:

1. R. V. Dukkipati , MATLAB: An Introduction with Applications, New age int Publ.
2. Chapman, S.J., MATLAB Programming for Engineers, 2nd ed.,
3. Chapra, S.C., Applied Numerical Methods with MATLAB, 2nd ed., McGraw-Hill, Prata, Rudra, Getting started with MATLAB—A Quick Introduction for Scientists and Engineers,


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

MME 2071: ADVANCED MECHANICAL ENGINEERING DESIGN

Module 1:

Introduction: Introduction to Advanced Mechanical Engineering Design. Review of materials and processes for machine elements. (5L)

Module 2:

Strength and Failure Theories: Review of static strength failure analysis, theories of failure including von-Mises theory based strength design. (5L)

Module 3:

Design for Fatigue, Creep and Surface Failure: High cycle and low cycle fatigue. Exercises of fatigue design of shafting, gears, and springs. (5L)

Module 4:

Design for Fatigue, Creep and Surface Failure: Surface fatigue design failures. Exercises of surface fatigue design of rolling contact bearings. (5L)

Module 5:

Design for Fatigue, Creep and Surface Failure: Design for creep. Combined creep and fatigue failure prevention. Design for corrosion wear, hydrogen embrittlement, fretting fatigue and other combined modes of mechanical failure. Case Studies of Mechanical Engineering Design Failures. (5L)

Module 6:

Axisymmetric Problems in Design: Thick-Walled Cylinders under Pressure, Compound Cylinders (Press or Shrink Fits). (5L)

Module 7:

Axisymmetric Problems in Design: Rotating Discs and Rotating Cylinders. (5L)

Text Books:

1. Machine Design, Robert L. Norton; Pearson Education India.
2. Optimum Design and Mechanical Elements, Roy C. Johnsons; John Wiley & Sons.
3. Mechanical Analysis and Design, Arthur H. Burr and John B. Cheatham; PHI.
4. Mechanical Design: An Integrated Approach, Ansel C. Ugural & Holmdel



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

MME2073: COMPUTER AIDED DESIGN OF MECHANICAL SYSTEM

Module 1:

CAD/CAM Systems: Introduction, Need & Scope of Computer Aided Machine Design, 3D Modeling and Viewing. (5L)

Module 2:

Geometric Modeling: Role of Geometric modeling, Curves. (5L)

Module 3:

Geometric Modeling: Surfaces, Solid modeling methods. (5L)

Module 4:

Computer Graphics: 2-D and 3-D transformations, Computer Animation. (5L)

Module 5:

Product Design and Development: Mass Properties, Assembly Modeling, Product Feature recognition from the database, Database structure for CAD, IGES, STEP & DXF data exchange format, Collaborative Design. (5L)

Module 6:

CAD Model & Design: Three-Dimensional modeling applications, Integration of design analysis & CAD. (5L)

Module 7:

Optimization: Overview of optimization methods in design, Formulation of optimization methods in design problems & their solution. (5L)

Text Books:

1. Andrew D. Dimarogonas, Computer Aided Machine Design, Prentice Hall International (USA) Inc.
2. Rao Y.C., Computer Aided Design & Manufacturing
3. Ramboldi and Dillman, Computer Aided Design & Manufacturing, Springer-Verlag.



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

MME 2075: ENGINEERING DESIGN METHODOLOGY

Module 1:

Fundamentals: principles of design, systematic approach, need analysis and design of specification; Conceptual design: developing function structure, developing concepts by systematic search with physical principles, classifying schemes. (5L)

Module 2:

Concept selection: matrix methods, necessity methods, probability methods, fuzzy set based methods, case study on consumer product; Embodiment design: basic rules, system modeling. (5L)

Module 3:

Preliminary design calculations and material selection, design considerations like force alignment, vibration etc., failure modes and effects analysis, design for manufacturability and assembly, case studies on design of machines. (5L)

Module 4:

Optimal and robust design: design problem formulation for analytical and numerical solution, design of experiments, Taguchi's method. Reverse engineering. (5L)

Module 5:

Physical prototyping; Lab: conceptual design, reverse engineering, design of simple sensors and actuators. (5L)

Module 6:


Hydraulic and pneumatic systems, motors and controller, product teardown and redesign, embodiment design. (5L)

Module 7:

CAE analysis, prototyping, design project. (5L)

Text Book

1. Yousef Haik, Engineering Design Process, Vikas Publishing house, New Delhi,
2. G. Pahl, and W. Beitz, Engineering Design – A Systematic Approach, Springer – Verlag,


Professor & Head
Department of Mechanical Engineering
Birsa Institute of Technology
MBSRA, RANCHI-835215

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for all M.Tech in Design of Mechanical Equipments

| SEMESTER / Session of Study (Recommended) | Course Level | Category of course | Course Code | Courses | Mode of delivery & credits <i>L-Lecture; T-Tutorial; P-Practicals</i> | | | Total Credits C- Credits | |
|--|-----------------|--|----------------|---|--|---------------------|---------------------|--------------------------------|-----------|
| | | | | | L (Periods/week) | T (Periods/week) | P (Periods/week) | C | |
| FIRST / Monsoon | FIFTH | THEORY | | | | | | | |
| | | Programme Core (PC) | ME521 | Computational Methods in Engineering | 3 | 0 | 0 | 3 | |
| | | | ME522 | Advanced Mechanics of Solids | 3 | 0 | 0 | 3 | |
| | | | ME523 | Applied Dynamics and Vibrations | 3 | 0 | 0 | 3 | |
| | | Programme Elective (PE)*(* <i>Student can choose only one of these</i>) | ME524 | Advanced Engineering Materials | 3 | 0 | 0 | 3 | |
| | | | ME525 | Robotic Manipulator Design | 3 | 0 | 0 | 3 | |
| | | | ME526 | Fluid Power and Control | 3 | 0 | 0 | 3 | |
| | | | ME527 | Applied Tribology | 3 | 0 | 0 | 3 | |
| | | Open elective OE | | Open Elective (OE) 1 | 3 | 0 | 0 | 3 | |
| | | LABORATORIES | | | | | | | |
| | | Programme Core (PC) | ME528 | Advanced Solid Mechanics and Vibration Lab | 0 | 0 | 4 | 2 | |
| | | | ME529 | Computational Methods Laboratory | 0 | 0 | 4 | 2 | |
| | | TOTAL | | | | | | | 19 |
| | | SECOND/ Spring | FIFTH | THEORY | | | | | |
| Programme Core (PC) | ME531 | | | Theory of Elasticity | 3 | 1 | 0 | 4 | |
| | ME532 | | | Fracture Mechanics | 3 | 1 | 0 | 4 | |
| | ME533 | | | Automatic Control | 3 | 0 | 0 | 3 | |
| Programme Elective (PE)*(* <i>Student can choose only one of these</i>) | ME534 | | | Mechanics of Composite Materials | 3 | 0 | 0 | 3 | |
| | ME535 | | | Finite Element Analysis | 3 | 0 | 0 | 3 | |
| | ME536 | | | Nonlinear Vibrations | 3 | 0 | 0 | 3 | |
| OPEN ELECTIVE OE | | | | Open Elective(OE) 2 | 3 | 0 | 0 | 3 | |
| LABORATORIES | | | | | | | | | |
| Programme Core (PC) | ME537 | | | Robotics Laboratory | 0 | 0 | 4 | 2 | |
| TOTAL | | | | | | | 19 | | |
| TOTAL FOR FIFTH LEVEL | | | | | | | 38 | | |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

| THIRD / Monsoon | SIXTH | THEORY | | | | | |
|---|-------|---------------------|---------------------------------|----------------|---|---|----|
| | | Programme Core (PC) | ME600 | Thesis Part I | | | |
| | | ME612 | Optimization Techniques | 3 | 0 | 0 | 3 |
| Programme Elective (PE)*(* Student can choose only one of these) | | ME613 | Vibration of Continuous Systems | 3 | 0 | 0 | 3 |
| | | ME614 | Rotor Dynamics | 3 | 0 | 0 | 3 |
| | | ME615 | Wave Propagation | 3 | 0 | 0 | 3 |
| LABORATORIES | | | | | | | |
| Programme Core (PC) | | ME616 | CAD Lab | 0 | 0 | 4 | 2 |
| TOTAL | | | | | | | 16 |
| FOURTH/ Spring | SIXTH | THEORY | | | | | |
| | | Programme Core (PC) | ME650 | Thesis Part II | | | |
| TOTAL | | | | | | | 16 |
| TOTAL FOR SIXTH LEVEL | | | | | | | 32 |
| GRAND TOTAL FOR M.TECH PROGRAMME (38 + 32) | | | | | | | 70 |


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

DEPARTMENT OF MECHANICAL ENGINEERING
PROGRAMME ELECTIVES (PE) Mtech in Design of Mechanical Elements
OFFERED FOR LEVEL 5-6

| PE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|------------|----------|----------------------------------|---------------------------------|---|---|---|---|
| 5 | ME524 | Advanced Engineering Materials | NIL | 3 | 0 | 0 | 3 |
| | ME525 | Robotic Manipulator Design | NIL | 3 | 0 | 0 | 3 |
| | ME526 | Fluid Power and Control | NIL | 3 | 0 | 0 | 3 |
| | ME527 | Applied Tribology | NIL | 3 | 0 | 0 | 3 |
| | ME534 | Mechanics of Composite Materials | NIL | 3 | 0 | 0 | 3 |
| | ME535 | Finite Element Analysis | NIL | 3 | 0 | 0 | 3 |
| | ME536 | Nonlinear Vibrations | NIL | 3 | 0 | 0 | 3 |
| 6 | ME613 | Vibration of Continuous Systems | NIL | 3 | 0 | 0 | 3 |
| | ME614 | Rotor Dynamics | NIL | 3 | 0 | 0 | 3 |
| | ME615 | Wave Propagation | NIL | 3 | 0 | 0 | 3 |

*** PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS**


Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

DEPARTMENT OF MECHANICAL ENGINEERING
OPEN ELECTIVES (OE)*
OFFERED FOR LEVEL 5-6

| OE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|------------|----------|------------------------------|---------------------------------|---|---|---|---|
| 5 | ME582 | Design Methodology | NIL | 3 | 0 | 0 | 3 |
| | ME583 | Renewable Source of Energy | NIL | 3 | 0 | 0 | 3 |
| | ME584 | Energy Management & Auditing | NIL | 3 | 0 | 0 | 3 |
| | ME585 | Industrial Robotics | NIL | 3 | 0 | 0 | 3 |
| | ME586 | Reliability in Design | NIL | 3 | 0 | 0 | 3 |

*** OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS**



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Programme Educational Objectives (PEOs) – Design of Mechanical Equipments

PEO 1: To prepare post graduates who will have strong fundamentals of conventional mechanical design and modern computational techniques for analyzing and improving mechanical equipment.

PEO 2: To prepare post graduates who will be competent enough to work successfully in challenging industrial environment.

PEO 3: To prepare post graduates who will be leading researcher and excellent academician.

PEO 4: To prepare post graduates who will work in a team to carry out multidisciplinary research and will be able to present a substantial technical report.

PROGRAM OUTCOMES (POs)

M. Tech. in Mechanical Engineering (Design of Mechanical Equipments)

PO1: A graduate shall be able to independently carry out research/investigation and development work to solve practical problems.

PO2: A graduate shall be able to write and present a substantial technical report/document.

PO3: A graduate shall be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.

PO4: A graduate shall have clear insight to appreciate the multidisciplinary nature of the technological field in design of mechanical equipment.

PO5: A graduate shall develop an ability to work in team, apart from having awareness of social needs and professional code of conduct, ethics and behaviour.



**Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215**

COURSE INFORMATION SHEET

Course code: ME 521

Course title: Computational Methods in Engineering

Pre-requisite(s): Mathematics course of UG level

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Learn different numerical techniques. |
| 2. | Learn linear algebra for solving problems. |
| 3. | Learn differential calculus to solve numerical problems |
| 4. | Learn integral calculus to solve numerical problems. |
| 5. | Apply numerical methods for solving engineering problems. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand several numerical techniques used in linear algebra. |
| CO2. | Solve systems of linear and nonlinear algebraic equations encountered in engineering problems. |
| CO3. | Evaluate differentiation and integration using different numerical techniques. |
| CO4. | Solve ordinary and partial differential equations using numerical methods |
| CO5. | Create new ideas in engineering computations. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Numerical Methods in Linear Algebra: Direct and iterative solution techniques for simultaneous linear algebraic equations – Gauss elimination, Gauss – Jordan, LU and QR decomposition, Jacobi and Gauss-Seidel methods, Eigenvalues and Eigenvectors – Power and inverse power method, physical interpretation of eigenvalues and eigenvectors, householder transformation. (8L)

Module 2:

Solution of nonlinear algebraic equations: Bisection method, fixed-point iteration method, Newton – Raphson, Secant method. **Interpolation:** Polynomial interpolation, Lagrange interpolating polynomial, Hermite interpolation, interpolation in two and three dimensions. (8L)

Module 3:

Numerical differentiation and Integration: Finite difference formula using Taylor series, Differentiation of Lagrange polynomials, Simpson's rule, Gauss – quadrature rule, Romberg method, multiple integrals. (8L)

Module 4:

Numerical solutions of ordinary differential equations: Euler's method, Heun's method and stability criterion, second and fourth order Runge- Kutta methods, Adams – Bashforth – Moulton method, system of ODEs and nonlinear ODEs. (8L)

Module 5:


Partial Differential Equations: Classifications of PDEs, Elliptic equations, parabolic equations, Hyperbolic equations (wave equation). (8L)

Text Books

1. Joe D Hoffman, Numerical Methods for Engineer and Scientists, Marcel Dekker.
2. S. P. Venkateshan and P. Swaminathan, Computational Methods in Engineering, Ane books.

Reference Books

1. Gilbert Strang, Computational Science and Engineering, Wessley – Cambridge press.
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGrawhill.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 522

Course title: Advanced Mechanics of Solids

Pre-requisite(s): Strength of Materials

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Understand the advanced concept of stress-strain behaviour of materials. |
| 2. | Understand the indicial notations. |
| 3. | Understand different elastic functions |
| 4. | Understand the mechanics of plate and shells. |
| 5. | Apply mathematical concept in practical solid mechanics problems. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the concept of tensor. |
| CO2. | Analyse advanced concept of stress and strain in structural problems. |
| CO3. | Apply the concept of different elastic functions to solve complex problems. |
| CO4. | Evaluate the influence of various geometric and loading parameters in plane stress and plane strain problems. |
| CO5. | Implement advanced concept of solid mechanics in torsion, plates and shells. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Mathematical Preliminaries

Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor.

(8L)

Module 2: Analysis of Stress and Strain

Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity. (8L)

Module 3: Problem formulation and solution strategies:

Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lamé-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. (8L)

Module 4: Two-dimensional problems


Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method. (8L)

Module 5: Applications

Torsion of noncircular shafts: Warping and Prandtl stress function, Torsion analysis of circular, elliptical, and rectangular cylinder using Warping and Prandtl function, Membrane analogy, Photo elasticity, Plates and shells – Fundamental equations, Kirchhoff's theory, axisymmetric bending of circular plates, membrane theory of shells of revolutions. (8L)

Text Books

1. Elasticity, Theory, Applications, and Numerics by Martin H. Sadd
2. Theory of Elasticity by Stephen Timoshenko and , J. N. Goodier
3. Advanced Mechanics of Solids, Otto T. Bruhns, Springer publications.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 523

Course title: Applied Dynamics and Vibration

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Understand advanced topics of rigid body kinematics and dynamics |
| 2. | Analyse free and forced vibration of single and multi-degree of freedom system |
| 3. | Apply principles of classical mechanics to analyse dynamical systems. |
| 4. | Design dynamical systems. |
| 5. | Understand working principles of gyroscopic couple. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Demonstrate various principles related to kinematics and dynamics of rigid bodies in space. |
| CO2. | Apply classical mechanical approach to construct equations of motion for dynamical systems |
| CO3. | Evaluate gyroscopic couple for systems with simultaneous spin and precession. |
| CO4. | Design and analyse simple dynamical systems. |
| CO5. | Evaluate natural frequencies and mode shapes of single and multi DOF vibrating systems. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Rigid Body Kinematics

Vectors, Frame of reference, Coordinate systems, Coordinate transformation, Rotating frames, Rotation tensor, Axis angle relation, Euler angles, Angular velocity, Five term acceleration formula, Practical examples. (8L)

Module 2: Rigid Body Kinetics

Linear momentum, Angular momentum, Moment of inertia and product of inertia, Laws of dynamics, Governing equations, Euler's equation, Steady state, Practical examples, Stability of bicycle, Gyroscope. (8L)

Module 3: Classical Mechanics

Generalized coordinates, Constraints, Degrees of freedom, Principle of virtual work, Lagrange multiplier, Stability of conservative system, D'Alembert's principle, Lagrange's equation of motion, holonomic and nonholonomic systems, Conservative systems, Legendre transformation, Hamiltonian mechanics. (8L)

Module 4: Introduction to Vibration

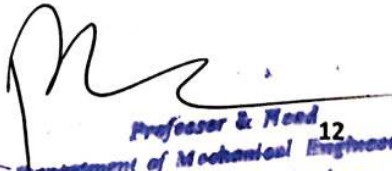
Basic elements of vibration, Free, damped and forced vibration, Logarithmic decrement, Half power band width, Base excitation, Transmissibility, Magnification factor, Response of general forcing, Torsional Vibration. (8L)

Module 5: Vibration of Multi DOF System

Two DOF system, Normal modes, Forced vibration, Dynamic vibration absorber, Free and forced multi DOF system, Lagrange's equation of motion, Dunkerley's formula, Rayleigh method, Holzer's method, Jacobi's method. (8L)

Text Books

1. J. L. Meriam and L. G. Kraige, Engineering Mechanics: Dynamics, John Wiley and Sons Inc., Seventh edition.
2. A. Chatterjee, Intermediate Dynamics, Indian Institute of Technology Kanpur, 2014.
3. D. T. Greenwood, Classical Dynamics, Dover Publications Inc.
4. L. Meirovitch, Elements of Vibration Analysis, McGraw Hill Education, Second edition.
5. S.S. Rao, Mechanical Vibrations, Pearson India Education Services Pvt Ltd. Fourth edition.


Professor & Head 12
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 524
Course title: Advanced Engineering Materials
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

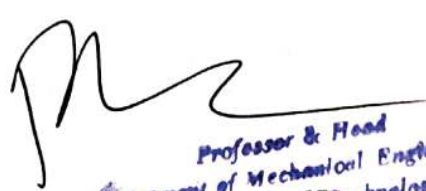
This course enables the students to:

| | |
|----|--|
| 1. | Identify the Discrepancy between theoretical and observed yield stress of crystals |
| 2. | Determine the relation between dislocation movement and plastic flow |
| 3. | Describe and explain the phenomenon of strain hardening in terms of dislocations and strain field interactions. |
| 4. | Discuss about natural fibres whose strength can be increased by different process technology. |
| 5. | Discuss about recyclability/disposability issues related to metals, glass, plastic & rubber and composite materials. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Describe the Discrepancy between theoretical and observed yield stress of crystals. |
| CO2. | Determine the relation between dislocation movement and plastic flow |
| CO3. | Analyse the phenomenon of strain hardening in terms of dislocations and strain field interactions. |
| CO4. | Evaluate the working stress of a material. |
| CO5. | Discuss about recyclability/disposability issues related to metals, glass, plastic & rubber and composite materials. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Introduction, Remarks on material science in the context of engineering

Structure of perfect and imperfect solids, elastic deformation and stress distribution, theoretical strength of crystals, Discrepancy between theoretical and observed yield stress of crystals, Linear Defects, Interfacial defects, Bulk or Volume defects, Atomic Vibrations, Burgers vectors. (8L)

Module 2: Dislocation and plastic deformation

Characteristics of dislocations, Slip planes and slip systems, Climb of edge dislocation, dislocation intersections, Stress field of an edge dislocation, Force on a dislocation, Strain energy of an edge and screw dislocation, relation between dislocation movement and plastic flow, dislocation generation, other modes of deformation in crystalline solids. (8L)

Module 3: Strengthening Mechanism

Dislocation theory of yielding, yield point phenomenon, strengthening by grain size reduction, solid solution strengthening, Resolved Shear Stress and Stress-to-Initiate-Yielding, Computations, plastic deformation of polycrystalline materials, deformation by twinning, strain hardening and recovery mechanism of deformation at elevated temperature, Recrystallization, Grain growth, mechanism of fracture, ductile-brittle transition. (8L)

Module 4: Mechanical behaviour of engineering materials

Under the fatigue, creeps and fracture design criteria for materials, Materials selection for a torsionally stressed shaft, environmental effects, thermal, electrical, magnetic and optical properties of materials, alloys for high temperature use, Data extrapolation methods (8L)

Module 5: Economical, Environmental and Societal issues in material science and engineering

Component design materials, recycling issues in material science and engineering, materials of importance, bio-degradable and bio-renewable polymers, Case studies: on dual nature of flow stress, effect of alloying on the flow stress components. (8L)

Text Books

1. Materials Science and Engineering an introduction, W.D. Callister Jr.
2. Physical Metallurgy Principles, R.E. Reed, R. Abbaschian

Reference books

1. Fracture an Advanced Treatise, H. Liebowitz
2. Fundamentals of Fracture Mechanics, J.F. Knott.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 525

Course title: Robotic Manipulator Design

Pre-requisite(s): Engineering Mathematics, Engineering Mechanics.

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand the kinematic design and dynamic formulation of a typical industrial robot. |
| 2. | Foresee the possibilities in design uncertainties in kinematic model of a robot and make necessary changes in the modelling to make the controller perform precisely. |
| 3. | Estimate the possible errors in dynamic forces/torques that may come on the actuators due to unmodeled parameters. |
| 4. | Understand the parallel robot kinematic design and solve its inverse and forward kinematics. |
| 5. | Attain the expertise necessary to evaluate a robot performance based on standard parameters. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Outline the structure of a typical robotic system, understand its link and joint parameters, and perform robot kinematics. |
| CO2. | Identify the geometric parameters of a serial robot by applying the knowledge of serial robot kinematics and generalized differential model of the robot. |
| CO3. | Identify the dynamic parameters of a serial robot by applying the knowledge of general form of dynamic equation of motion. |
| CO4. | Analyse planar and spatial parallel robots in context to its forward and inverse kinematics, and evaluate its singularity, condition number and manoeuvrability. |
| CO5. | Design a robotic manipulator and evaluate its primary and secondary workspace. Evaluate the performance of an industrial robot based on ISO standards. |



Professor & Head
Department of Mechanical Engineering
IIT Ranchi
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction to serial and parallel robot structure, standard kinematic notations, transformation matrices, link and joint parameters, forward and inverse kinematics, calculation of kinematic Jacobian, Euler angles, Singularity and Redundant robots. (8L)

Module 2:

Calibration of geometric parameters: Geometric parameters, parameters of robot location, parameters of end-effector, Generalized differential model of the robot, General form of calibration model, Identification of geometric parameters, Autonomous calibration methods. (8L)

Module 3:

Dynamic modelling of a serial robot, concept of moment of inertia, general form of dynamic equation of motion, calculation of energy, Lagrange-Euler formulation, Properties of dynamic model, effect of friction, actuator's rotor inertia, environmental forces. Identification of dynamic parameters, choice of identification trajectories, Evaluation of joint coordinates and torques, Practical considerations. (8L)

Module 4:

Modelling of parallel robots: Parallel robot characteristics, advantages, disadvantages, structure and applications. Planar 3 Degrees of Freedom (DoF) manipulator, Spatial 6 DoF manipulators, Inverse geometric model and inverse kinematics, Singularities and statics, Manoeuvrability and condition number, Direct geometric model. (8L)

Module 5:

Performance analysis of Robots: Accessibility, Workspace of a robot manipulator: primary and secondary spaces, Orientation workspace, Concept of aspects and connectivity, Local performances: Manipulability, Repeatability, Isotropy, Lowest singular value. ISO Standards. (8L)

Text Books

1. Etienne Dombre and Wisama Khalil, Robot Manipulators: Modeling, Performance Analysis and Control, ISTE, 2007.
2. S. K. Saha, Introduction to Robotics, McGraw Hill Education, 2008.
3. J. P. Marlett, Parallel Robots, Springer, 2006.

Reference Books

1. Bruno Siciliano and Oussama Khatib, Handbook of Robotics, Springer, 2016.
2. KS Fu, C. S. G Lee, R. Gonzalez, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill Education, 1987.
3. ISO 9283:1998 Manipulating industrial robots -- Performance criteria and related test methods, ISO, 1998.

 Professor & Head
Department of Mechanical Engineering
IIT Roorkee
MESA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 526

Course title: Fluid Power and Control

Pre-requisite(s): Fundamental of Fluid power control, Fluid Mechanics

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand various aspects of Fluid power which starts with emphasis on fluid mechanics and governing laws. |
| 2. | Be exposed to fundamentals and specific cases of control valves such as Direction, Pressure and Flow control. |
| 3. | Be familiarized with Servo and Electro hydraulic valves briefly. |
| 4. | Design and control hydraulic and pneumatic circuits. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the fundamental theoretical concepts governing fluid power. |
| CO2. | Recognise common hydraulic and pneumatic components (pumps, actuators, motors, valves, etc.), their use, symbols, and their performance characteristics. |
| CO3. | Identify the actual components and fluid power circuits found in common industrial applications. |
| CO4. | Formulate and analyse mathematical models of hydraulic and pneumatic circuits. |
| CO5. | Design and implement simple fluid power systems common in industrial applications using commercial components: circuits for directional, speed, pressure, force, and flow control. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws. Distribution of fluid power, ISO symbols, energy losses in hydraulic systems. Applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis. Performance curves and parameters. (8L)

Module 2:

Hydraulic actuators, types and constructional details, lever systems, control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve Analysis and Design. (8L)

Module 3:

Proportional control valves and servo valves. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Design and analysis of typical hydraulic circuits. Regenerative circuits, high low circuits, Synchronization circuits, and accumulator sizing. Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits, accessories used in fluid power system, Filtration systems and maintenance of system. (8L)

Module 4:

Components of pneumatic systems; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling. (8L)

Module 5:

Components of pneumatic systems: Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will dependent control, Travel-dependent control and Time dependent control, combined control, Program Control, Electro-pneumatic control and air-hydraulic control, Ladder diagrams. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working. (8L)

Text Books

1. Herbert E. Merritt: Hydraulic control systems, John Wiley and Sons Inc.
2. Fundamental of Fluid power control, Watson, Cambridge University press
3. Fluid Power Control, Jagadeesha T, Wiley India Limited


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 527

Course title: Applied Tribology

Pre-requisite(s): Industrial Tribology

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Comprehend the concept of tribology for applying lubrication in bearings and other machine elements. |
| 2. | Design the tribological systems consisting bearings. |
| 3. | Apply modern technologies of surface texturing for performance improvements of bearings. |
| 4. | Derive governing equations of all types of bearings using knowledge of fluid mechanics. |
| 5. | Solve general Reynolds equation for lubrication problems using FDM. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the basic concepts of friction, wear, and lubrication. |
| CO2. | Apply the knowledge of surface texture parameters for selection of bearing materials. |
| CO3. | Write Reynold's equation for various bearing problems and design thrust bearings. |
| CO4. | Design journal bearings and squeeze-film bearings. |
| CO5. | Design hydrostatic and rolling element bearings. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Friction, Wear, and Lubrication, Tribology principles, Principles for selection of bearing types, Lubricants and Lubrication, Mineral oils, Synthetic oils, Viscosity, Density and compressibility, Thermal Properties, Oil life, Greases, Solid lubricants, Lubricant supply methods. (8L)

Module 2:

Surface Texture and Interactions, Geometric characterization of surfaces, Surface parameters, Measurement of surface texture, Measurement of surface flatness, Statistical descriptions, Contact between surfaces, Lubrication regime relation to surface roughness, Bearing Materials, Distinctive selection factors, Oil-film bearing materials, Dry and semi-lubricated bearing materials, Air bearing materials, High-temperature materials, Rolling bearing materials. (8L)

Module 3:

Fundamentals of Viscous Flow, Conservation of mass, momentum, and energy, non-dimensionalisation, Reynolds Equation and Applications, Performance parameters, Thrust Bearings, Thrust bearing types, Design factors, Performance analysis, Design procedure. (8L)

Module 4:

Journal Bearings, Full-arc plain journal bearing with infinitely long approximation, Boundary conditions, Definition of the Sommerfeld number, Cavitation phenomena, Bearing performance parameters, Finite journal bearing design and analysis, Bearing Stiffness, Rotor Vibration, and Oil-Whirl Instability, General design guides, Squeeze-Film Bearings, Governing equations, Planar squeeze film, Nonplanar squeeze film, Squeeze film of finite surfaces, Piston rings. (8L)

Module 5:

Hydrostatic Bearings, Types and configurations, Circular step thrust bearings, Capillary-compensated hydrostatic bearings, Orifice-compensated bearings, Design procedure for compensated bearings, Hydraulic lift, Rolling Element Bearings, Ball bearing types, Roller bearing types, Thrust bearing types, Load-life relations, Adjusted rating life, Static load capacity. (8L)

Text Books

1. M. M. Khonsari and E. R. Booser. Applied Tribology: Bearing Design and Lubrication, Second Edition. John Wiley & Sons, Ltd, 2008.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 528

Course title: Advanced Solid Mechanics and Vibration lab

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Determine material properties. |
| 2. | Understand fatigue and creep phenomena. |
| 3. | Understand vibration characteristics.. |

Course Outcomes

At the end of this course, a student should be able to:

| | |
|------|--|
| CO1. | Determine surface hardness of materials |
| CO2. | Determine creep strength of materials under different temperatures |
| CO3. | Evaluate fatigue strength of materials under different loading conditions |
| CO4. | Evaluate material properties under different loading conditions using Instron |
| CO5. | Analyse dynamic characteristics of wheel balancing, tuned vibration absorber, and weakly coupled pendulum. |

List of Experiments

Experiment 1: To determine surface hardness of mechanical components using micro hardness testing machine.

Experiment 2: To determine creep properties of materials (Lead, polymer materials) in room temperature

Experiment 3: To determine change of rate of deformation of a sample (Lead, polymer materials) at different temperature.

Experiment 4: To determine fatigue strength of material under tensile load (Rumul Fatigue Testing Machine)

Experiment 5: To determine fatigue strength of material under compressive load (Rumul Fatigue Testing Machine)

Experiment 6: To determine fatigue strength of material under flexural load (Rumul Fatigue Testing Machine)


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

- Experiment 7:** To determine the properties of materials under tensile load in Instron
Experiment 8: To determine the properties of materials under compressive load in Instron.
Experiment 9: To determine the properties of materials under flexural load in Instron.
Experiment 10: To determine secondary mass and spring stiffness for forced tuned vibration absorber
Experiment 11: To understand beating phenomenon in weakly coupled pendulum
Experiment 12: To determine balancing masses and their orientation for an unbalanced wheel in wheel Balancing Machine

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 529
Course title: Computational Methods Laboratory
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Compute the mathematical problems using MATLAB |
| 2. | Analyse engineering problems using finite element packages ANSYS and COMSOL |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Solve system of linear and algebraic equations using MATLAB |
| CO2. | Evaluate numerical differentiation and integration using MATLAB |
| CO3. | Solve system of ordinary differential equations using MATLAB |
| CO4. | Analyse Plane stress, Plane strain, and torsion problems using finite element package ANSYS |
| CO5. | Analyse plate and shell problems, and equation-based modelling using finite element package COMSOL Multiphysics. |

List of Experiments

Experiment 1: Solving system of linear algebraic equations with MATLAB: Gauss elimination, Gauss – Jordan, and Gauss-Seidel method.

Experiment 2: Solving nonlinear algebraic equations and Polynomial interpolation with MATLAB: Newton – Raphson method and Lagrange interpolating polynomial.

Experiment 3: Numerical differentiation and integration with MATLAB: Finite difference, Simpson's, and Gauss – quadrature rule.

Experiment 4: Solving ordinary differential equations with MATLAB: Euler's and Heun's method.

Experiment 5: Analysis of a Plane stress problem using ANSYS.

Experiment 6: Analysis of a Plane strain problem using ANSYS.

Experiment 7: Analysis of an Antiplane strain problem using ANSYS.

Experiment 8: Analysis of Torsion of circular shafts using ANSYS.



34 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Experiment 9: Analysis of Plane stress and Plane strain problems using COMSOL.

Experiment 10: Analysis of Torsion of noncircular shafts using COMSOL.

Experiment 11: Analysis of axisymmetric bending of circular plates using COMSOL.

Experiment 12: An Equation based modelling in COMSOL.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |


Professor ~~85~~ Wood
Department of Mechanical Engineering
Mrita Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 531

Course title: Theory of Elasticity

Pre-requisite(s): ME 522– Advanced Mechanics of Solids

Co- requisite(s): Nil

Credits: 4 **L:** 3 **T:** 1 **P:** 0

Class schedule per week: 04

Class: M. Tech.

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Present the mathematical and physical principles in understanding the continuum behaviour of solids. |
| 2. | Understand advanced topics of elasticity. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Analyse finite and nonlinear elastic deformation behaviour of solid material. |
| CO2. | Implement the idea of linear and nonlinear constitutive equations in the field of elasticity of materials. |
| CO3. | Apply mathematical principles (Poisson's equation, Green's theorem, etc.) to solve three-dimensional problems. |
| CO4. | Understand variational and complex variable method for solving elasticity problems. |
| CO5. | Create new ideas in the area of theory of elasticity. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Analysis of Finite Deformations

Material and spatial description of a continuous body, Deformation gradient tensor, Cauchy-Green deformation tensor, Deformation of line and surface element, Polar decomposition of deformations, Principal stretches and principal axes of deformation, Strain invariants, Alternative stress measures – first and second Piola- Kirchhoff stress tensor. (10L)

Module 2: Constitutive Equations

Linear constitutive equations, Generalized Hooke's Law, Material Symmetry, Monoclinic Materials, Orthotropic Materials, Transversely Isotropic Materials, Isotropic Materials, Nonlinear constitutive equations, theory of finite elastic deformations. (5L)

Module 3: Three – dimensional problems

Field theory - Poisson's Equation, Three-Dimensional Dirac Delta Function, Helmholtz's Representation Theorem, Green's Theorem, Potentials in Elasticity -Displacement Potentials, Papkovitch Representation, Kelvin's Problem, Mindlin's Problem, Boussinesq's problem. (8L)

Module 4: Variational Methods

Calculus of Variations - Process of "Taking Variations", Lagrange Multipliers, Energy Theorems in Elasticity - Principle of Virtual Work, Principle of Minimum Potential Energy, Complementary Strain Energy Density, Principle of Minimum Complementary Energy, Approximate Solutions - Rayleigh-Ritz Method. (8L)

Module 5: Complex Variable Methods

Review of complex variable theory, Formulation of plane elasticity problems, Resultant boundary conditions, General structure of complex potentials, Circular domain problems, Plane and half-plane problems, Applications using method of conformal mapping. (9L)

Text Books

1. Continuum Mechanics, A.J.M Spencer, Dover Publications, INC
2. Elasticity, Theory, Applications, and Numerics by Martin H. Sadd
3. Theory of Elasticity by Stephen Timoshenko and, J. N. Goodier

Reference Books

1. An Introduction to Continuum Mechanics, J. N. Reddy, Cambridge University Press.
2. The Linearized Theory of Elasticity, W. S. Slaughter, Springer Science+Business Media, LLC



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 532
Course title: Fracture Mechanics
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 4 **L:** 3 **T:** 1 **P:** 0
Class schedule per week: 04
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Review basics of Solid Mechanics and Fracture Mechanics |
| 2. | Analyse crack propagation in linear elastic regime. |
| 3. | Develop Finite Element Model for linear and nonlinear elastic materials. |
| 4. | Analyse fracture in viscoelastic materials |
| 5. | Develop Mathematical Models for crack growth |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate basics of Fracture Mechanics |
| CO2. | Apply linear elastic approach to analyse crack propagation |
| CO3. | Apply numerical technique to analyse fracture in composite materials |
| CO4. | Analyse deformation and fracture in viscoelastic materials |
| CO5. | Develop Mathematical Models to predict and arrest crack |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Introduction and Overview

Current Fracture Mechanics and its application. Elements of Solid Mechanics: Stress analysis, Equilibrium Equation, Strain analysis Compatibility Equation, Strain energy Density, Elastic Boundary Value Problem, Rubber Elasticity, Principle of Virtual work. Viscoelasticity: Linear Viscoelastic Materials, Thermorheologically Simple Materials. Elastoplasticity: Yield Criteria, Incremental Plasticity, Deformation Plasticity. (6L)

Module 2: Linear Elastic Fracture Mechanics

Linear Elastic Crack Tip Field, The Stress Intensity Factor (close form solution and Numerical Method). Energetics of Cracked Bodies: The Energy Release Rate, The J-Integral. The Plastic Zone and Fracture Toughness. Dynamic Fracture Mechanics: Dynamic Crack Propagation and Arrest Concepts, Mathematical Basis of Dynamic Fracture Mechanics, Application of Dynamic Fracture Mechanics. (8L)

Module 3: Fracture Mechanics Model for Fiber Reinforced Composites

Classifications and Terminology for Composites, Basic Mechanical Behaviour of Composite structures, Anisotropic Fracture Mechanics, Micromechanical Failure process. Nonlinear Fracture Mechanics analysis: Continuum Models, Hybrid Models, Finite Element Modes. (6L)

Module 4: Stationary Crack-Tip Fields

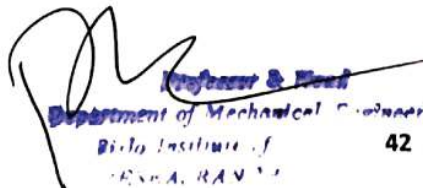
Elastic Secondary Creep, Elastic Primary Creep, Primary Secondary Creep, Plastic-Primary Creep, Elastic-Exponential Law Creep, The ΔT_k Integral. Creep Crack Growth: Elastic-Secondary Creep Crack Field, Steady State Crack Growth, Transient Crack Growth, Elastic-Primary Creep Crack Fields, Creep Crack Growth Correlations. (8L)

Module 5: Basic considerations in prediction of Fatigue Crack Propagation

Constant Amplitude Fatigue Crack Growth Relations, Load Interaction Effects, The Crack Closure Concept. Theoretical Models for Fatigue Crack Propagation: The Model of Budiansky and Hutchinson, The inclined Strip Yield Model, The Short Crack Problem in Fatigue, Fatigue Crack Growth in Welds. (12L)

Text Books

1. Advanced Fracture Mechanics, M. F. Kanninen and C. H. Popelar


Professor & Head
Department of Mechanical Engineering
Birla Institute of
42
BIRLA INSTITUTE OF

COURSE INFORMATION SHEET

Course code: ME 533

Course title: Automatic Control

Pre-requisite(s): Engineering Mathematics, Engineering Mechanics

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Express dynamic systems in form of differential equations, state space models, transient responses, transfer functions and frequency responses. |
| 2. | Analyse the stability, steady state properties, controllability and observability, and fastness and damping of a linear system. |
| 3. | Evaluate closed loop systems with respect to stability, as well as robustness against and sensitivity for model errors and disturbances |
| 4. | Interpret and apply graphical methods and tools like block diagrams, root locus, Bode and Nyquist diagram to design simple controllers. |
| 5. | Understand the function of simple controllers (PID controllers, lead-lag filters, state feedback) and controller structures (feedforward and cascade control) |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Outline the working of a typical open-loop and closed loop control systems and can mathematically define and solve any dynamic system expressed as linear time invariant differential equations. |
| CO2. | Apply the knowledge of proportional, derivative and integral controllers to design a controller and analyse its stability. |
| CO3. | Analyse a control system using root-locus and apply root locus method to design a control system. |
| CO4. | Analyse a control system using frequency response (bode-plots) and evaluate the stability of a controller using Nyquist criterion. |
| CO5. | Design a servo-system based on state-space representation and define its controllability and observability. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction to control system, open-loop and closed loop systems, Laplace transforms, Inverse Laplace transforms, Solving linear time-invariant differential equations. Mathematical modelling of dynamic systems: Transfer function and Impulse response, Block diagrams, Modelling in state space, Mechanical, Electrical and Thermal systems, Linearization. (8L)

Module 2:

Transient Analysis: First and Second order systems and its analysis, Basic Control systems: Proportional, Integral and Derivative (PID) Control, Routh's stability criterion, Pneumatic, Hydraulic and Electronic controllers. (8L)

Module 3:

Root Locus Analysis in Control system, Rules for constructing a root locus, Control system design by root locus method: Lead and lag compensation. (8L)

Module 4:

Frequency response analysis: Bode plots, Nyquist stability criterion, Stability analysis, Closed loop frequency response, control system design by frequency response: Lead and lag compensation. (8L)

Module 5:

Analysis of Control system in State space, State-space representation for transfer functions, Controllability and Observability, Solving the time invariant state equation. Design of control systems in State-space, Pole placement, State observers, Design of servo systems. Tuning of PID controllers, Applications of Automatic Control and PLC. (8L)

Text Books

1. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India, 2013.
2. N. S. Nise, Control Systems Engineering, Wiley, 2008.
3. Madan Gopal, Control System Engineering, New Age Int. Publication, 2007.

Reference Books

1. Benjamin Kuo, Automatic Control System, Prentice Hall of India, 1995
2. Raven, F.H., Automatic Control Theory, McGraw Hill, 1995.
3. B. C. Nakra, Theory and Applications of Automatic Controls, New Age Int. Publication, 2017.


46
Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME 534
Course title: Mechanics Of Composite Materials
Pre-requisite(s): Nil
Co-requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Present a comprehensive exposure to different composite materials |
| 2. | Do various types and kinds of fabrication of composite materials |
| 3. | Develop an intuitive understanding of Polymer, ceramic, metal based Composite materials. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Correlate requirement of composite materials. |
| CO2. | Understand applicability and mechanics of composite materials under various conditions. |
| CO3. | Characterize necessity of choice of various components of composite materials and their forms like filler, fibre, nano etc. with relative properties. |
| CO4. | Apply various techniques for suitable composite material with required enhanced properties. |
| CO5. | Evaluate the performance composite materials for engineering applications. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction to Composite Materials Applications: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. Applications: Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites. (7L)

Module 2:

Fiber Reinforced Plastic Composite Materials Processing: Lay-up and curing, fabricating process, open and closed mould process, hand lay-up techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding. (8L)

Module 3:

Macro Mechanics of a Lamina: Two - dimensional relationship of compliance and stiffness matrix, Engineering constants, Stress-Strain relations for lamina of arbitrary orientation, Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai-Wu tensor theory, Numerical problems. (9L)

Module 4:


Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Hooke's law for different types of materials, Number of elastic constants, Numerical problems. (8L)

Module 5:

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application. Fabrication Process for MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques. (8L)

Text Books

1. R.M. Jones, Mechanics of Composites, 2nd ed., Taylor & Francis, 1999.
2. T. G. Gutowski, (Ed.) Advanced Composites Manufacturing, John Wiley & Sons, New York 1997.
3. P.M. Ajayan, L. Schadler, P.V. Braun Nano Composite Science and Technology, Wiley VCH, 2003.


Department of Mechanical Engineering
Birla Institute of Technology
MESKA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME535

Course title: Finite Element Analysis

Pre-requisite(s): Engineering Mathematics, Fundamentals of Programming Language, Mechanics of materials, Thermodynamics

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Understand the basic concepts and procedures in finite element analysis. |
| 2. | Analyze different types of mechanics problems in engineering using the finite element method. |
| 3. | Apply hands-on experience on conducting various mechanics analyses by using a state-of-the-art finite element software. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the basics of Finite Element Analysis, viz. Continuous and discrete systems. |
| CO2. | Evaluate structural problems using energy methods. |
| CO3. | Analyze different approaches and theorems to structural problems in finite elements for two dimensions. |
| CO4. | Implement the concept of Iso-parameteric mapping in sub-modeling, sub-structuring using finite element programming. |
| CO5. | Apply the concept of Finite Element Methods in different practical engineering analysis. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Overview of engineering systems

Continuous and discrete systems (discussion on differential equations, matrix algebra), steady state, propagation and eigenvalue problems. (8L)

Module 2: Energy methods

Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, Rayleigh-Ritz Formulation, development of bar and beam element, application to truss and frames. (8L)

Module 3: Finite elements for two-dimensions

Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates. (8L)

Module 4: Iso-parametric mapping

Iso-parametric mapping, numerical integration, Assembly procedure, solution techniques, Jacobian matrix. Numerical integration – 2- and 3-point Gauss Quadrature, full and reduced integration. Sub-modeling, sub-structuring, introduction to finite element programming. (8L)

Module 5: Case study


Torsion of prismatic bars, modal analysis; direct integration methods for dynamic analysis; contact analysis, applications to problems in engineering: plane elasticity, heat conduction, potential flow and Transient problems. Computer implementation (8L)

Text Books

1. Chandrupatla T . R., and Belegundu, A. D., Introduction to Finite Elements in Engineering, Prentice Hall, 2003.
2. Reddy, J. N., An Introduction to the Finite Element Method, 3rd Edition, McGraw-Hill Science/Engineering/Math, 2005.
3. Bhatti, M.A., Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations, Wiley, 2005.

Reference Books

1. Bathe, K-J., Finite Element Procedures, Prentice Hall, 1996.
2. Logan D. L., A First Course in the Finite Element Method, Thomson- Engineering, 3rd edition, 2001.
3. Zienkiewicz, O.C. and Taylor, R.L., The Finite Element Method, 6th Ed., Vol. 1, Elsevier, 2005.


Professor B. S. Prasad
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME536
Course title: Nonlinear Vibrations
Pre-requisite(s): Nil
Co-requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand dynamics of nonlinear systems. |
| 2. | Analyse free and forced vibration characteristics of nonlinear systems. |
| 3. | Learn approximation methods to analyse nonlinear systems |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Demonstrate understanding of linear stability and bifurcation of nonlinear systems. |
| CO2. | Apply knowledge of perturbation methods for approximate solutions of nonlinear systems. |
| CO3. | Apply knowledge of heuristic methods for approximate solutions of nonlinear systems. |
| CO4. | Analyse parametrically excited nonlinear systems. |
| CO5. | Pursue active research in the field of nonlinear vibration. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Linear Stability and Bifurcation

Overview of linear and nonlinear vibrations, Types and sources of nonlinearities in mechanical systems, Phase space and trajectories, Linear stability analysis and phase space, introduction to basics of bifurcations of two (and higher) dimensional systems. (10L)

Module 2: Perturbation Methods

Regular perturbation method, Poincare-Linstedt method, method of averaging, Method of multiple scales; Application to Duffing and van der Pol equations. (8L)

Module 3: Heuristic Methods

Harmonic balance method, Equivalent linearization method, Galerkin Method, Collocation Techniques, Application with examples. (7L)

Module 4: Floquet Theory for Parametrically excited Systems

Parametrically excited systems, stability of periodic solutions, Meissner equation, Mathieu-Hill equation, Determination of Floquet multipliers. (7L)

Module 5: Forced Nonlinear Systems

Forced vibration of Duffing oscillator for sub-harmonic resonance, Forced vibration of van der Pol Oscillator, Poincare maps, Lyapunov exponents for maps and flows. (8L)

Text Books

1. S. H. Strogatz, Nonlinear Dynamics and Chaos, Levant Books, 2007
2. D. W. Jordan and P. Smith, Nonlinear Ordinary Differential Equations, Oxford University Press, Fourth edition.
3. L. Meirovitch, Methods of Analytical Dynamics, Dover Publications.

Reference Books

1. A. H. Nayfeh and D. T. Mook, Nonlinear Oscillations, John Wiley and Sons Inc., 1995.

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Application of Method of multiple scales to higher dimensional systems
POs met through Gaps in the Syllabus: PO1, PO3 & PO4

COURSE INFORMATION SHEET

Course code: ME537

Course title: Robotics Laboratory

Pre-requisite(s): Engineering Mathematics, Engineering Mechanics, MATLAB

Co-requisite(s): Nil

Credits: 2 **L:** 0 **T:** 0 **P:** 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Learn about industrial robots and systems and its safe handling. |
| 2. | Create a kinematic and dynamic robot simulation of robot using scientific visualization tools like V-Rep or MATLAB/Sim Mechanics. |
| 3. | Be acquainted with standard industrial robot, its sub-systems and prepare application programs for standard industrial tasks. |
| 4. | Gain a hands-on experience in a rigging an industrial pneumatics and electro-pneumatics circuit and integrate with a PLC. |
| 5. | Identify the kinematic parameters and troubleshoot a given robotic system. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Be acquainted with standard industrial robot, safe handling, its sub-systems and prepare application programs for standard industrial tasks. |
| CO2. | Apply the knowledge of robot kinematics to identify the kinematic parameters of standard industrial robot |
| CO3. | Analyse a given robot system using virtual simulation tools and interpret the results of kinematics, forward and inverse dynamics. |
| CO4. | Design and create pneumatic and electro-pneumatic circuits using PLC. |
| CO5. | Build up an aptitude to troubleshoot any unknown problem in a standard electro-pneumatic circuit. |

List of Experiments

Experiment 1: Introduction to Industrial Robot (KUKA KR5 Arc): Frames, Safety, Teach Pendant, etc.

Experiment 2: End-effector tool and base calibration and manual/CAD verification.

Experiment 3: Program industrial robot for a standard pelletizing operation.

Experiment 4: Identification of DH Parameters of a 3R Spatial robot through experiment and verification using robot simulation tool like, Robo Analyzer.

61

Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Experiment 5: Electro-pneumatic circuit design for automated single cylinder reciprocating action.

Experiment 6: Sequential double cylinder reciprocating action using electro-pneumatic circuit.

Experiment 7: PLC: Introduction to Ladder Logic Programming.

Experiment 8: Interfacing electro-pneumatic circuit for single cylinder using PLC.

Experiment 9: Troubleshooting of electro-pneumatic circuit for an unknown fault.

Experiment 10: Using MATLAB/Sim Mechanics for perform mechanical simulation.

Experiment 11: Create and simulate a 3R robot in MATLAB/Sim Mechanics and verify its forward kinematics.

Experiment 12: Extend the MATLAB/Sim Mechanics model to verify analytical inverse kinematics solution.

Experiment 13: Use MATLAB/Sim Mechanics to perform inverse and forward dynamics of a 2R planar robot.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |


| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome


Prof. G. S. & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME600

Course title: Thesis Part I

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 8 L: T: P:

Class schedule per week:

Class: M.Tech.

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215
64

COURSE INFORMATION SHEET

Course code: ME612

Course title: Optimization Techniques

Pre-requisite(s): Mathematics, Basics of operation research

Co-requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Formulate the different engineering optimization problems using the concept of optimization technique. |
| 2. | Develop basic concept of algorithm to solve the different engineering optimization problems. |
| 3. | Analyse and appreciate different algorithm methods in the field of optimization technique. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand and formulation of various engineering optimization problem. |
| CO2. | Analyse the single variable optimization algorithm. |
| CO3. | Analyse the multi variable optimization algorithm. |
| CO4. | Analyse the constrained optimization algorithm. |
| CO5. | Design and modelling of specialized algorithm. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-832015

SYLLABUS

Module 1: Introduction

Introduction to optimization, optimal problem formulation: design variables, constraints, objective function, variable bounds, engineering optimization problems, optimization algorithms. (8L)

Module 2: Single variable optimization algorithms

Optimality criteria, bracketing methods, regional –elimination method, point estimation method, gradient based method, root finding using optimization techniques. (8L)

Module 3: Multi variable optimization algorithms

Optimality criteria, Unidirectional search, direct search method: evolutionary optimization method, Simplex search method. (8L)

Module 4: Constrained Optimization algorithms

Transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search technique. (8L)

Module 5: Specialized algorithms


Integer Programming: penalty function, branch and bound method, geometric programming, Bathtub curve, Genetic algorithm (GA): working principle, Differences and similarity between GAs and traditional methods, GAs for constrained optimization, real coded GAs, Advanced Gas. (8L)

Text Books

1. Kalyanmoy Deb, "Optimization for Engineering Design", First Edition, Prentice-Hall India Publishers, 2009.
2. Singiresu S. Rao, "Engineering Optimization theory and practice", Third Edition, New Age Publishers, 2018.

Reference Books

1. Jasbir Arora, "Optimal Design", Mc Graw Hill (International) Publishers.
2. D. E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", First Edition, John Wiley Publishers, 2009.
3. Kalyanmoy Deb, "Multi Objective Optimization using Evolutionary Algorithms", Wiley Student Edition.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME613

Course title: Vibration of Continuous Systems

Pre-requisite(s): Engineering Mathematics, Engineering Mechanics, Basic Mechanical Vibration

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Set-up initial-boundary value problems for some important and fundamental structural members viz. bars, strings, membrane and plates. |
| 2. | Find analytical and approximate solutions to above mentioned problems for various loading and boundary conditions. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Define various continuous systems viz. strings, bars, beams, plates |
| CO2. | Formulate those continuous systems-using various techniques |
| CO3. | Solve the continuous systems under free and forced vibration conditions. |
| CO4. | Calculate the response of the systems. |
| CO5. | Analyse the response of the systems of various practical applications. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Vibrations of strings and bars

Dynamics of strings and bars: the Newtonian formulation, Dynamics of strings and bars: the variational formulation, Free vibration problem: Bernoulli's solution, Modal analysis, The initial value problem: solution using Laplace transform, Forced vibration analysis, approximate methods for continuous systems, Continuous systems with damping, Non-homogeneous boundary conditions. (9L)

Module 2: One-dimensional wave equation: D'Alembert's solution

D'Alembert's solution of the wave equation- The initial value problem, The initial value problem: solution using Fourier transform, Harmonic waves and wave impedance, Energetics of wave motion, Scattering of waves, Applications of the wave solution. (7L)

Module 3: Vibrations of beams

Equation of motion, Free & Forced vibration problem analysis, Non-homogeneous boundary conditions, The Timoshenko beam, Damped vibration of beams, Special problems in vibrations of beams- Influence of axial force on dynamic stability, Beam with eccentric mass distribution, Problems involving the motion of material points of a vibrating beam. (7L)

Module 4: Vibrations of membranes

Dynamics of a membrane, Modal analysis-The rectangular membrane, the circular membrane, Forced vibration analysis, Waves in membranes- Waves in Cartesian coordinates, Waves in polar coordinates, Energetics of membrane waves, Initial value problem for infinite membrane. (8L)

Module 5: Vibrations of plates

Dynamics of plates, Vibrations of rectangular plates- Free vibrations, Orthogonality of plate Eigen functions, Forced vibrations, Vibrations of circular plates - Free vibrations, Forced vibrations, Waves in plates, Plates with varying thickness. (8L)

Text Books

1. P. Hagedorn & A. Dasgupta, Vibrations & waves in continuous mechanical systems, John Wiley & Sons Ltd.
2. S S Rao, Vibration of Continuous System, John Wiley & Sons Ltd, 2007.

Reference Books

1. L. Meirovitch, Elements of Vibration Analysis, McGraw Hill Education (India), 1986.
2. A W Leissa & M S Qata, Vibrations of Continuous System, McGraw Hill Education, 2011.


71 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME614

Course title: Rotor Dynamics

Pre-requisite(s): Mechanical Vibrations

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Understand the rotor dynamics phenomena with the help of simple rotor models and subsequently the modern analysis methods for real life rotor systems. |
| 2. | Model and analyse the rotor-bearing dynamics |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Write the equation of motion for vibration problems |
| CO2. | Solve the equation of motion for free lateral response of simple rotor models |
| CO3. | Model a rotor using Finite Elements method and generate elemental and global matrices |
| CO4. | Analyse the free lateral response of complex rotor systems and comprehend the features of Eigenvalues and Eigenvectors |
| CO5. | Analyse the forced lateral response and critical speeds of complex rotor systems |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215
74

SYLLABUS

Module 1: Introduction to Rotor Dynamics

Rotating machine components, introduction to vibration analysis, single degree of freedom systems, multi degree of freedom systems, imposing constraints and model reduction, time series analysis, the Fourier transform, the discrete Fourier transform. (8L)

Module 2: Free Lateral Response of Simple Rotor Models

Co-ordinate systems, gyroscopic couples, dynamics of a rigid rotor on flexible supports, a rigid rotor on isotropic flexible supports, complex co-ordinates, a rigid rotor on anisotropic flexible supports, forward and backward whirl, natural frequency maps, the effect of damping in the supports, simple model of a flexible rotor. (8L)

Module 3: Finite Element Modelling

Defining generalized co-ordinates, finite element modelling of discrete components, axial deflection in a bar, lateral deflection of a beam, developing general element matrices, assembling global matrices, general finite element models. (8L)

Module 4: Free Lateral Response of Complex Systems


Co-ordinate systems, disk elements, shaft elements, Euler-Bernoulli beam theory, including shear and rotary inertia effects, the effect of axial loading, mass and stiffness matrices for shaft elements, gyroscopic effects, the effect of torque, tapered shaft elements, rotor couplings, bearings, seals and rotor-stator interactions, modelling foundations and stators, assembly of the full equations of motion, free response of complex systems, features of eigenvalues and eigenvectors. (8L)

Module 5: Forced Lateral Response and Critical Speeds

Modeling out-of-balance forces and moments, response of a rigid rotor on isotropic supports to out-of-balance forces, response of a Jeffcott rotor to out-of-balance forces, response of an isotropic rotor system to out-of-balance moments, response of a rigid rotor on anisotropic supports to out-of-balance forces and moments, forward and backward whirl orbits, complex rotor models, forces on the supports due to rotor vibration, response to ground vibration, critical speeds, mode shapes associated with critical speeds, maps of critical speeds and mode shapes. (8L)

Text Books

1. Friswell, M. I., Penny, J. E. T., Garvey, S. D., Lees, A. W. Dynamics of rotating machines. Cambridge University Press, 2010.


Professor & Head
Department of Mechanical Engineering
751014 Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME615
Course title: Wave Propagation
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III /06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Review basics of Vibration Problems |
| 2. | Solve one-dimensional wave problems |
| 3. | Apply wave solutions to various mechanical system |
| 4. | Analyse vibration, and wave propagation in membrane |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand vibration in various systems |
| CO2. | Analyse one-dimensional wave problems |
| CO3. | Apply wave solution to continuous mechanical systems |
| CO4. | Analyse wave propagation in membrane structure |
| CO5. | Design system comprise of fluid and solid interaction |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Introduction and Overview

Vibration in Discrete System: Single Degree of Freedom System, Multi Degree of Freedom System. Hamilton Principle; Variation Formulation. Longitudinal and Transverse vibration in String; Longitudinal, Transverse and torsional vibration of Euler-Bernoulli's beam. (8L)

Module 2: One-dimensional wave equation

d'Alembert's solution of the initial value problem, solution of initial value problem using Fourier transform. Harmonic waves and wave impedance; Energetics of wave motion. Scattering of waves: Reflection at a boundary, scattering at a finite impedance. (8L)

Module 3: Application of wave solution

Impulsive start of a bar, step-forcing of bar with boundary damping, axial collision of bar, string on a compliant foundation, axially translating string. (6L)

Module 4: Dynamics of membrane

Newton formulation, Variation formulation. Waves in membranes: wave in cartesian coordinates, wave in polar coordinates, Energetics of membrane waves, initial value problem for infinite membranes, reflection of plane waves. (8L)

Module 5: Waves in fluids

Acoustic waves in fluids: The acoustic wave equation, planar acoustic waves, Energetics of planar acoustic waves, reflection and refraction of planar acoustic waves, spherical and cylindrical waves, waves in wave guides, acoustic waves in a slightly viscous fluid. (8L)

Text Books

1. Vibration and Waves in Continuous Mechanical Systems, P. Hagedorn and A. DasGupta, John Wiley & Sons, Ltd

Reference Books

1. Computational Methods in structure Dynamics, Leonard Meirovitch

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Theoretical and experimental correlation of mechanical waves with regards to industry. POs met through Gaps in the Syllabus: PO3

Topics beyond syllabus/Advanced topics/Design:

Wave propagation simulations.

POs met through Topics beyond syllabus/Advanced topics/Design: PO1 to PO5

79
Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME616
Course title: CAD Lab
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M.Tech.
Semester / Level: III/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---------------------------------------|
| 1. | Do Solid Modeling using CAD Software. |
| 2. | Generate CAD curves. |
| 3. | Interface CAD and FE packages |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Perform solid modeling of mechanical parts. |
| CO2. | Model assemblies of mechanical equipments. |
| CO3. | Generate Drawing / Orthographic View. |
| CO4. | Develop program for 2-D and 3-D transformation. |
| CO5. | Develop programs for design, drawing and plotting of machine element. |

List of Experiments

Experiment 1: Review of 2-Dimensional drawing.

Experiment 2: 3-Dimensional modelling and assembly of Foot step bearing using CREO.

Experiment 3: 3-Dimensional modelling and assembly of Cotter joint bearing using CREO.

Experiment 4: Writing program for 2-D and 3-D transformation for Translation, Scaling, and Rotation.

Experiment 5: Writing program for 2-D and 3-D transformation for Shearing and Reflection.

Experiment 6: Generation of Bezier curve.

Experiment 7: Generation of Hermite and B-Spline curve.

Experiment 8: Development of programs for design, drawing and plotting of machine element: Shaft.

82 *Professor & Head*
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Experiment 9: Development of programs for design, drawing and plotting of machine element: Gears.

Experiment 10: Development of programs for design, drawing and plotting of machine element: Connecting rod.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome


Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 |
|-----|-----|-----|-----|-----|-----|
| CO1 | 2 | 2 | 3 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 2 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 2 | 1 |
| CO5 | 2 | 2 | 3 | 2 | 1 |

< 34% = 1, 34-66% = 2, > 66% = 3


 83 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME650

Course title: Thesis Part II

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 16 L: T: P:

Class schedule per week:

Class: M.Tech.

Semester / Level: IV/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

FIRST SEMESTER

THEORY:

| A. COMPULSORY SUBJECTS (THREE) | | Lecture | Lab | Tutorials | Credits |
|---------------------------------------|---|----------------|------------|------------------|----------------|
| MMA – 1003 | Computational Mathematics (Breadth Paper) | 3 | 0 | 0 | 3 |
| MCD – 1001 | System Analysis and Design | 3 | 0 | 0 | 3 |
| MCD – 1003 | Engineering Elasticity & Plasticity | 3 | 0 | 1 | 4 |

| B. ELECTIVE SUBJECTS (ANY TWO) | | | | | |
|---------------------------------------|---|---|---|---|---|
| MCD – 1005 | Advanced Dynamics and Vibration | 3 | 0 | 0 | 3 |
| MCD – 1007 | Mechanics of Composite Materials | 3 | 0 | 0 | 3 |
| MCD – 1009 | Fracture Mechanics & Theory of Failures | 3 | 0 | 0 | 3 |
| MCD – 1011 | Nanotechnology | 3 | 0 | 0 | 3 |
| MCD – 1013 | Hydraulic & Pneumatic Controls | 3 | 0 | 0 | 3 |
| MSE – 1007 | Software Engineering (Breadth Paper) | 3 | 0 | 0 | 3 |

| C. LABORATORY | | | | | |
|----------------------|--|---|---|---|---|
| MCD – 1016 | Computer Programming and Software Lab | 0 | 2 | 0 | 2 |
| MCD – 1002 | Computer Aided Analysis & Design lab-I | 0 | 2 | 0 | 2 |

Total Minimum number of credits to be Registered in First Semester **20.0**

Prerequisite: CS-312 UNIX & C Programming: Non-Credit Course


Professor & Head
Department of Mechanical Engineering
DIT Institute of Technology
BESRA, RANCHI-835215

SECOND SEMESTER

THEORY:

| A. COMPULSORY SUBJECTS | | Lectures | Lab | Tutorials | Credits |
|-------------------------------|--|-----------------|------------|------------------|----------------|
| MCD – 2001 | Finite Element Method in Solids & Structures | 3 | 0 | 1 | 4 |
| MCD – 2003 | Computer-Aided Design | 3 | 0 | 0 | 3 |

B. ELECTIVE SUBJECTS (ANY THREE)

| | | | | | |
|------------|--|---|---|---|---|
| MCD – 2005 | Computer-Aided Manufacturing Systems | 3 | 0 | 0 | 3 |
| MCD – 2007 | Theory of Optimization and Design | 3 | 0 | 0 | 3 |
| MCD – 2009 | Modeling Analysis & Simulation | 3 | 0 | 0 | 3 |
| MCD – 2011 | Mechatronics | 3 | 0 | 0 | 3 |
| MCD – 2013 | Virtual Prototyping & Manufacturing | 3 | 0 | 0 | 3 |
| MCD – 2015 | Thermal Engineering & Tribology | 3 | 0 | 0 | 3 |
| TCS – 7052 | Artificial Intelligence & Intelligent Systems (Breadth paper) | 3 | 0 | 0 | 3 |
| MEE – 2001 | Soft Computing Techniques (Breadth paper) | 3 | 0 | 0 | 3 |


C. LABORATORY

| | | | | | |
|------------|--|---|---|---|---|
| MCD – 2002 | Computer Aided Analysis & Design Lab.-II | 0 | 2 | 0 | 2 |
| MCD – 2006 | Automation & Robotics Lab | 0 | 2 | 0 | 2 |

Total Minimum Number Credits to be Registered in Second Semester **20.0**

THIRD SEMESTER

| | | |
|------------|--------|------|
| MCD – 3001 | THESIS | 15.0 |
|------------|--------|------|


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

FOURTH SEMESTER

MCD - 4001 THESIS

20.0

Total no of Credits

$$20.0 + 20.0 + 15.0 + 20.0 = 75.0$$


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

DETAILED SYLLABI:

MMA - 1003 COMPUTATIONAL MATHEMATICS

- **Partial Differential Equations:** Classification of partial differential equations. Its characteristics and reduction to canonical forms. Affine transformation. Solution of higher order p.d.e. with variable coefficients by Monge's method. Boundary value problems. Two-dimensional heat conduction equation. Laplace's equation in different coordinate systems. Vibrating membrane.
- **Calculus Of Variations:** Extrema of functions of several variables, Lagrange's multipliers. External properties of characteristic values of $(A-B) X = 0$. The Euler equation of variations, The extrema of integrals under constraints. Sturm-Liouville problems. Hamilton's principle and Lagrange's equations.
- **Eigen values and Eigen vectors of matrices:** Basic properties of eigen values and eigen vectors. The power method. The Rayleigh quotient. Inverse iteration. Jacobi's methods, Given and Householder's methods. Leverrier-Faddeeva method. Sylvester's expansion theorem and computation of $f(A)$.
- **Numerical Methods:** Finite difference method for parabolic, elliptic and hyperbolic equations. Explicit and implicit schemes. Convergence and stability of schemes.
- **Introduction to finite element method:** Concept of functionals. Raleigh-Ritz and Galerkin's techniques. Application to two dimensional problems. Finite element method for one dimensional problems. Application to two-dimensional problems.

Text and Reference Books:

1. *Introductory Methods of Numerical Analysis*", S.S. Shastry
2. *"Advanced Engineering Mathematics"*, E. Kreyszig

MCD - 1001 SYSTEM ANALYSIS & DESIGN

- **Systems concepts and systems environment:** Definition, Characteristics of a system, Elements of a system, Types of system.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215


- **System development life cycle:** Recognition of need, Feasibility study, Analysis, Design, Implementation, Post implementation and maintenance, considerations for candidate systems.
- **Roles of the system analyst:** Change agent, Investigator and monitor, Architect, Psychologist, Salesperson, Motivator, politician, The analyst /User interface-behavioural issues, conflict resolution, MIS organization.
- **System Analysis:** System planning and the initial investigation, Information gathering, The tools of structured analysis, Feasibility study, Cost/benefit analysis, System proposal.
- **Systems Design:** Application architecture and modeling, Database design, Output design and prototyping, Input design and prototyping, Processor design and prototyping, User interface design.
- **Advanced Analysis and Design Methods:** Object-oriented analysis and modeling, Object-oriented design and modeling.
- **Application of System Analysis and Design:** Mechanical, electrical, electronics, information and other systems. Design philosophy- fail safe and safe life.

Text & Reference Books:

1. *System Analysis and Design, Kenneth Kendall & Julie Kendall, Prentice-Hall of India Pvt. Ltd, Newdelhi, fifth edition 2005.*
2. *System Analysis and Design, Elias M. Awad, Galgotia Publications (P) Ltd, New Delhi, 1998.*
3. *System Analysis and Design Methods, J. L. Whitten, L. D. Bently, K. C. Dittman, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, fifth edition, 2001*

MCD-1003 ENGINEERING ELASTICITY AND PLASTICITY

- Components of stress at a point, tensorial character, Cauchy's stress relations, Principal stresses and stress invariants. Octahedral stress components.

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Homogeneous and deviatoric stress components. Equilibrium equations. Boundary conditions.


- Components of strain at a point. Tensorial character. Principal strains and strain invariants. Strain –displacement relations. Compatibility conditions. Generalised Hooke's law. Engineering and Lami's elastic constants. Plane stress and plane strain problems. Biharmonic equation.
- Principle of superposition. Uniqueness theorem. St. Venant's principle. Stress functions. Plane problems in Cartesian co-ordinates. Solutions by polynomials. Plane problems in polar coordinates. Complex stress functions.
- Semi-inverse method. Torsion of bars of circular and noncircular cross sections. Membrane analogy. Thin-walled open cross-sections.
- Strain energy. Principle of virtual work. Minimum potential energy principle. Problems of strings, beams and plates.
- Yield criteria. Stress space. Tresca's and Von Mises' theories of failure. Yield curves on Π -plane. Conventional and natural stress and strain. Stress –strain relations in restricted and unrestricted plasticity. Idealised stress-strain diagrams and dynamic models of mechanical behaviour.
- Elasto-plastic problems. Spherical and cylindrical pressure vessels. Rotating discs. Mechanics of metal forming. Sinking of thin walled tubes, wire drawing and other problems. Slip-line field theory. Stress and displacement equations

Text & Reference Books:

1. *Theory of Elasticity: Timosenko and Goodier*
2. *Plasticity for Engineers: Johnson & Mellor*
3. *Fundamentals of Theory of Plasticity: L.M. Kachanov*
4. *Elasticity in Engineering: Ernest E. Sechler, Dover Publications Inc., 1968*
5. *Applied Elasticity: C.T. Wang, McGraw Hill Book Co. 1953.*

MCD - 1005 ADVANCED DYNAMICS AND VIBRATIONS

- Introduction, Brief history of vibrations classification of vibration and vibrating system some basic definition Axioms Hamilton principle, principle of virtual work, Lagrange equations.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215


- Free Vibration analysis of single degree of freedom (SDF) Undamped translational and torsional systems, Damped vibrations of SDF, Different types of damping used in practice.
- Forced vibrations of SDF systems, formulations for rotating unbalance, whirling of rotating shaft base excitation, transmissibility and vibration isolations, introduction to vibration measuring instruments.
- Linear theory of free and forced vibrations of two – Degree-of-freedom systems, coordinate coupling, principal coordinates and orthogonality of modes.
- Vibration analysis of multi – degree-of-freedom systems, influence coefficients, matrix formulation, numerical techniques in determination of natural frequencies multi-degree-of-freedom systems.
- Free vibrations of continuous systems, strings, bars shafts and beams, Effect of rotary inertia, approximate methods, Raleigh's method, Rayleigh – Ritz method, collocation method, Galerkin's method used to determine natural modes.

Text & Reference Books:

1. *Structural Dynamics, Theory and Computations: Mario Paz, CBS Publishers & Distributors, Delhi, 1987*
2. *Theory of Vibration with Application: W.T. Thomson*
3. *Mechanical Vibration Analysis: P. Srinivasan*
4. *Elements of Vibrational Analysis: Leonard Meirovitch, McGraw Hill Book Co, 1986*

MCD - 1007 MECHANICS OF COMPOSITE MATERIALS & STRUCTURE

- Introduction, various reinforcements and matrix materials. Strength and stiffness properties. Effective moduli calculation. Three-dimensional anisotropy constitutive theory. Edge effects and interlaminar stresses. Temperature dependent properties.


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215


- Laminates: Laminated plates. Analysis of strength and design with composites. Pressure vessels design with composites.
- Life Prediction: Prediction of strength and life of composite materials and structures, Micro mechanics, effects of damage accumulations, damage mechanics, life prediction concepts and methods.

Text & Reference Books:

1. *Mechanic of composite materials: R.M.Jones*
2. *Mechanic of composite materials: R.M. Christensen*
3. *Structural Stability of Columns & Plates: N.G.R. Iyenger.*
4. *Analysis and Performance of Fiber Composites: B. D. Agarwal & L. J. Bruteman.*

MCD - 1009 FRACTURE MECHANICS AND THEORY OF FAILURES

- Linear elastic and elastoplastic models of local stress fields around crack tips. Concepts of stress intensity and strain energy release rate, Strain energy density.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Concepts of crack opening displacement and J integral fracture criteria. Correlation of mathematical models with fracture toughness testing, Fracture safe designing of structures and machine components, failure analysis.

Text & Reference Books:

1. *Engineering Fracture Mechanics: David Broak*
2. *Fundamentals of Fracture Mechanics: J.F. Knott*
3. *Fracture Mechanics: R. L. Carlson, Orient Longmans 1998.*



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

MCD - 1011 NANOTECHNOLOGY.

- **Introduction to Physics of Solid State:** Structure, Energy bands, Localized particles.
- **Methods of Measuring Properties:** Atomic structures, Crystallography, Microscopy, Spectroscopy.
- **Properties of Individual Nanoparticles:** Metal nano-clusters, Semi-conducting nano-particles, Methods of synthesis.
- **Carbon Nanostructures:** Carbon molecules, Carbon clusters, Carbon nanotubes, Application of carbon nanotubes.
- **Bulk Nanostructured Materials:** Solid disordered nanostructures, Nanostructured crystals.
- **Nanostructured Ferromagnetism:** Basics of ferromagnetism, Effects of bulk nanostructuring of magnetic properties, Dynamics of nanomagnets, Nanopore containment of magnetic particles, Nanocarbon ferromagnets.
- **Optical and Vibrational Spectroscopy:** Infrared frequency range, Luminescence, Nanostructures in Zeolite Cages.
- **Quantum Wells, Wires, and Dots:** Preparation of quantum nanostructures, Size and dimensionality effects, Excitons, Single electron Tunneling, Applications-infrared detectors, quantum dot lasers, Superconductivity.
- **Self Assembly and Catalysis:** Process of self-assembly, Semiconductor islands, Monolayers, Catalysis-Nature of catalysis, Surface area of nanoparticles, porous materials, pillored clays, colloids.
- **Organic compounds and Polymers:** Forming and characterizing polymers, Nanocrystals, Polymers-conductive and block copolymers, Supramolecular structures.
- **Nanomachines and Nanodevices:** MEMS, NEMS, Molecular and supramolecular switches.

Text & Reference Books:

1. *Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, Wiley-Interscience, Hoboken, New Jersey, 2003.*


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

2. *Nanotechnology -An Introduction to Nanostructuring Techniques*, Michael Kohler, Wolfgang Fritzsche, wiley-VCH Verlag GmbH & Co., First Edition, 2004.
3. *Nanotechnology*, Gregory Timp Ed. , Springer-Verlag, New York, 1999
4. *Nanoscale Materials*, Luis M. Liz-Marzan & Prashant V. Kamat Eds., Kluwer Academic Publishers, Boston, 2003.
5. *Science of Fullerenes & Carbon Nanotubes*, M. S. Dresselhaus, P. C. Eklund, Academic Press, New York, 1996.



Professor & Head
Department of Mechanical Engineering
Birsa Institute of Technology
MESRA, RANCHI-835215

MCD - 1013 HYDRAULIC & PNEUMATIC CONTROLS

- Generation and utilization of fluid power, Fluid power components and circuits, Positive displacement pumps and motors, pump losses and efficiency, linear actuators, different control valves, servo valves, proportional valves, computer interfacing of hydraulic drive, hydraulic drive cards, programmable logic controllers, online data acquisition system.
- Transfer function and block diagram for hydraulic system, Steady state and transient response analysis for servo valves and motors, stability analysis, Routh's and Nyquist criterion, fluidic valves and Boolean operations.
- Hydraulic Reservoirs & Accumulators; General valve analysis, valve coefficients, Modeling on valve control and pump control actuator, modeling of electro-hydraulic servo valve, Stability analysis of hydro-mechanical servo and relief valve, Matlab-Simulink Modeling of hydraulic systems; Design of Hydraulic Circuits; Seals & Packings; Hydraulic Pipes, Hoses and Fittings.
- Introduction to Pneumatic Control; Control Principles; Interacting Circuits; Some Applications of Basic Pneumatic Circuits; Sequences and Piloting Devices; Negative Feedback Control; Standard Ancillary Valve Arrangements and its Application; Pneumatic Circuit Design.

Text & Reference Books:

1. *D. McCloy and H. R. Martin, "Control of Fluid Power, Analysis, Design and Control", John Wiley & Sons*
2. *F. X. Kay, "Pneumatic Circuit Design", Machinery Publishing Co. Ltd, London, 1966*
3. *H. E. Merrit, "Hydraulic Control System", John Wiley & Sons.*
4. *J. F. Blackburn., G. Reethof, J. L. Shearer, "Fluid Power Control", Tech Press of MIT and John Wiley & Sons.*
5. *S. R. Majumdar, "Oil Hydraulic Systems-Principles & Maintenance", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2001.*
6. *B. Lall, "Oil Hydraulics at The Service of Machine", Durga Prasad Yugal Kishore Baranwal Publishing, Mazaffarpur, 1978.*

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

MSE - 1007 Software Engineering Principles & Practices


- **Introduction to Software Engineering.** Project size and its categories. Planning a software project. Software development life cycle. Planning and organizational structure.
- **Software cost Estimation:** Cost factors, cost estimation techniques, Maintenance cost estimation. Software requirements, specifications. Formal specification techniques.
- **Verification and validation techniques:** Quality assurance, walkthroughs and inspections. Testing fundamentals, types of testing, testing tools, automated testing, formal verification. Software tools. Overview of CASE.
- **Software Maintenance:** Maintenance characteristics and tasks, side effects, reverse engineering techniques.
- **Software reliability:** Software errors, faults, repair and availability, availability models, software maintenance. Management aspects of maintenance, maintenance tools and techniques.

Text & Reference Books:

1. *Software Engineering Concepts*, R. Fairley, McGraw Hill, 1992.
2. *Software Engineering*, R.S.Pressman, McGraw Hill, 1996
3. *Software Engineering Concept*, T.G. Lewis, McGraw Hill, 1992

MCD - 2001 FINITE ELEMENT METHOD IN SOLIDS & STRUCTURES

- **Introduction to FEM, integral formulations:** Variational method, weighted residual methods. Elements types and properties. One dimensional element, Shape functions for one and two dimensional elements- triangular and quadrilateral elements, Boundary conditions.
- **Element matrices:** Galerkin formulation, Two-dimensional grids, linear triangular and bilinear rectangular elements.
- **Coordinate systems:** Local coordinate systems, natural coordinate systems, area coordinate system, global coordinate systems.

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

- **Energy methods:** Solution techniques. Mesh refinement. Convergence criterion. Application to frames, beams and axial elements. Plane stress. Plane strain. Axisymmetric problems. Application to vibrational problems.

Text & Reference Books:

1. *Applied Finite Elements Analysis :- Larry J. Segerlind.*
2. *An Introduction to the Finite Element Method:- J.N. Reddy*
3. *Finite Element Method for Engineers: H. K. Huebner, John Wiley & Sons, 1975.*
4. *Text Book of Finite Element Analysis- P. Seshu, Prentice- Hall of India Private Ltd, New Delhi, 2004.*

MCD-2003 COMPUTER AIDED DESIGN

- **CAD/ CAM systems:** Introduction, 3D modeling and viewing, Modeling aids and tools, Engineering drawings, CAD/CAM programming.
- **Geometric modeling:** Curves, Surfaces, NURBS, Solids, features.
- **Computer Graphics:** Graphic display, Transformations, Visualization, Computer animation.
- **Product Design and Development:** Mass Properties, Assembly modeling, Product data exchange, Data exchange standards, Database for CAD/CAM, Collaborative design.
- **Product Manufacturing and Management:** Engineering tolerances, Computer aided Process planning, PART programming, Product life cycle Management. Development of CNC controllers and machine tool robots as material handling devices.

Text & Reference Books:

1. *Mastering CAD/CAM: Ibrahim Zeid, Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 2007*
2. *CAD, CAM and Robotics: M. P. Grover, Prentice-Hall of India, 1994*
3. *Computer Control of Machines and Manufacturing System, Y. Koren*
4. *Knowledge Intensive CAD: - Mantyle & Finger.*
5. *Computer Aided Design: - V. Ramamurti, TMH, New Delhi.*



 Professor & Head
 Department of Mechanical Engineering,
 Birla Institute of Technology
 MESBA, RANCHI-835215

MCD – 2005 COMPUTER AIDED MANUFACTURING SYSTEMS

- **INTRODUCTION TO MANUFACTURING AUTOMATION:** Fundamentals of manufacturing systems and automation need for system approach in manufacturing, types and needs of manufacturing automation, basic elements of an automated manufacturing system.
- **NUMERICAL CONTROL MANUFACTURING:** Problems with conventional numerical control, principle of operation of CNC, features and advantages of CNC, direct numerical control (DNC), types and functions of DNC, advantages of DNC, Adaptive control machining system, types and benefits adaptive control.
- **ROBOT TECHNOLOGY:** Robot anatomy and physical configuration of industrial robot, basic robot motions, specification of robots, robot end effectors / grippers, tools.
- **FLEXIBLE MANUFACTURING SYSTEM:** Classification, structure and operation of FMS, types of flexibility in FMS, design aspects of FMS, benefits of FMS.
- **PROCESS PLANNING:** Computer aided process planning, variant and generative approach, situational case studies and analysis.
- **COMPUTER NETWORKS FOR MANUFACTURING:** Hierarchy of computers in manufacturing, benefits of hierarchical structure, local area networks (LAN), manufacturing automation protocol (MAP), technical and office protocol (TOP).
- **COMPUTER INTEGRATED MANUFACTURING:** Evolution of CIM, key challenges in CIM, subsystems of CIM, Computer integrated manufacturing wheel.

Text & Reference Books:

1. *Tien-Chen Chong, R. A. Wysk, Hsu-Pin Wang, " Computer-Aided Manufacturing" Second Edition, Printice-Hall Inc., Englewood Cliffs, New Jersey, 1998.*
2. *Chris McMahan & Jimmie Brown, " CAD/CAM Principles, Practice and Manufacturing Management", Pearson Education Asia, Second Edition, 2001*
3. *Surender Kumar & A. K. Jha, Technology of CAD/CAM*
4. *P. Radhakrishnan, S. Subramanyanan and V. Raju, "CAD/CAM/CIM".*

 **Professor & Head**
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

5. *P. N. Rao, N. K. Tewari and T. K. Kundra, " Computer-Aided Manufacturing", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2007.*
6. *Mastering CAD/CAM: Ibrahim Zeid, Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 2007*

MCD - 2007 THEORY OF OPTIMIZATION AND DESIGN

- **Introduction to optimization:** Statement of an optimization problem, Classification of optimization problems, **Optimization techniques:** Classical techniques, Linear programming, Nonlinear programming with equality and inequality constraints Geometric programming, Dynamic programming, Integer programming, Stochastic programming.

Text & Reference Books:

1. *Engineering Optimization Theory & Practice, Singiresu S. Rao*
2. *Principles of Operations Research with Applications: H.M. Wagner*
3. *Analytical Decision Making in Engineering Design: Siddal*
4. *Combinatorial optimization: Algorithms & Complexity: C.H. Papadimitron*

MCD - 2009 MODELLING ANALYSIS AND SIMULATION

- **Introduction to modeling & simulation:** Modeling and model types, Needs and techniques of simulation.
- **Probability Theory & Distribution:** Review of probability and statistics, random variates-discrete & continuous distribution function, distribution fitting.
- **Modeling:** Mathematical representation of processes, problem identification, model construction, testing and calibration, evaluation and applications.
- **Modeling applications to engineering system:** Population process, traffic flow, structural systems, hydrodynamic processes and other physical systems. Econometric models, Network models.
- **Simulation Techniques:** Monte Carlo & retrospective simulation. Random event representation. Discrete & continuous process simulation. Event scan & time scan techniques. Statistical evaluation of simulation output - transient and steady state response. Upper and lower confidence limit etc.


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RAJ. 831015


- **Special purpose languages & Simulation Application:** Various simulation languages and software typical examples and case studies of simulation experiments.

Text & Reference Books

1. *Simulation Modeling and Analysis, Averill M. Law and W. David Kelton, Third edition, McGraw-Hill International series, 2000.*
2. *A First Course in Mathematical Modeling, Frank R. Giordano, Maurice D. Weir and William P. Fox, Third edition, Thomson Publications, 2003.*
3. *Discrete-Event System Simulation, Jerry Banks, John S. Carson II, Barry L. Nelson, David Nicol, Fourth edition, Pearson Education India, 2004.*
4. *System Simulation, Geoffrey Gordon, Second edition, Prentice Hall PTR, 2004.*

MCD-2011 MECHATRONICS

- **Introduction:** Control of mechanical systems, Interfacing micro-controllers with a mechanical system, Overview of sensors, transducers, micro controllers and computer monitoring.
- **Sensors and transducers:** Sensors and transducers for measuring displacement, velocity, force, pressure, liquid flow, temperature, stress & strain etc.
- **Signal conditioning:** Signal conditioning, operational amplifiers, protection, filtering, wheatstone bridge, analogue and digital signals, multiplexers, pulse modulation.
- **Data presentation systems:** Data presentation elements, magnetic recording displays, Data acquisition systems, measurement systems, testing and calibration.
- **Various Actuation systems:**
 - a) Hydraulic and pneumatic systems
Circuits, pumps, valves, linear and rotary actuators
 - b) Mechanical systems
Cam, gear trains, belt and chain drives, bearings
 - c) Electrical systems
D.C motors, A.C motors, stepper motors, solenoids


 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

- **System models and transfer functions:** Mathematical model for the system, transfer function and block diagram for the system, first and second order system.
- **Dynamic responses of the system and stability:** Unit step transient response for first and second order systems, system stability, Routh's criterion, frequency response, Nyquist's criterion.
- **Closed loop controllers:** Proportional, Derivative, Integral and PID controllers, controller tuning
- **Microprocessors:** Control, microcomputer structure, micro controllers.
- **Programmable logic controllers:** Basic structure, programming and ladder diagram, latching, sequencing, timers, Internal Relays, counters.
- **Some Mechatronic systems:** Xerox machine, Robotic control, CNC machines, Rapid prototyping, Mechatronic Cars, Automatic washing machines, ATM, Aircrafts, industrial process controllers etc.

Text & Reference Books:

1. *Mechatronics, Bolton W, Pearson Education, 2nd Edition:*
2. *Mechatronics: N P Mahalik, Tata McGraw Hill Publication*
3. *Mechatronics: Alaiatore D G and Histan M. B, Tata McGraw Hill Publication*

MCD - 2013 VIRTUAL PROTOTYPING & MANUFACTURING

- Principles of Virtual Reality and 3-D Graphics; Application of 3-D Graphics and Virtual Reality in Manufacturing; Automation & Simulation; Virtual Reality Modeling; Motion; Collision Detection; Networking and related Issues.

Text & Reference Books:

MCD - 2015 THERMAL ENGINEERING & TRIBOLOGY

- Course overview; Fundamental principles; Transfer phenomena-analogy, momentum, heat and mass transfer; Thermal boundary layer flows; Modeling thermal transport process in typical engineering systems, simplified modeling techniques and experimental interfacing; Convective heat transfer- limiting

 **Professor & Head**
Department of Mechanical Engineering
Birla Institute of Technology
ESRA, RANCHI-835215

condition flows, parallel flows (Hagen-Poiseuille flow, Couette flow, sudden acceleration of a flat plate, stagnation flow, creeping flow (i.e. MEMS microfluidics); Natural convection (similarity solutions); Mass transfer- diffusion & convection; Combined heat and mass transfer; Heat transfer in porous media Tribology overview, friction wear & lubrication; Lubrication-types of lubrication, Shiebeck curve, boundary lubrication, surface film formation & failure, elasto hydrodynamic lubrication, hydrodynamic & hydrostatic lubrication; Fluid dynamics in lubrication; Newtonian fluid, Compressible & incompressible fluids; Theory of hydrodynamic lubrication; Lubricants- function, types of lubricants, solid, liquid, semi solid & gaseous, mineral, natural & synthetic lubricants, gaseous lubricants, greases, additives, special purpose lubricants, lubricant properties & testing; Triboelements- bearings types, journal bearing, babbits, important steps in design.

Text & Reference Books:

1. *Fundamentals of Heat and Mass Transfer, F. P. Incropera and B. Lavine, Wiley & Sons, Sixth Edition, 2006.*
2. *Fundamentals of Momentum, Heat, and Mass Transfer, J. Welty, C. Wicks, R. Wilson & G. Rorrer, Wiley & Sons, Fourth Edition, 2000.*
3. *Heat & Mass Momentum Transfer, Rehsennow and Choi, Prentice-Hall, 1980*
4. *Basic Lubrication Theory, A, Cemeron*
5. *Introduction to Tribology of Bearings, B. C. Majumdar*

CS - 312 UNIX & C PROGRAMMING

- **Unix:** Unix file, system, directories, permissions and directory hierarchy. Shell, shell commands, variables, looping, filters, grep family, Sed, Awk, shell programming, programming with standard IO, Unix systems calls, low level I/O file system development, inodes, document presentation, Nroff and Troff applications.
- **C Language:** Basics, types of operations and expressions, variable names, data types. Arithmetic, relational and logical operators type conservation. Bit wise logical operators and conditional expressions. Control flow: Statements and blocks,


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MBSRA, RANCHI-835215

if-else, else-if, switch, loops, while, and, for, do while, break, continue, go to and labels.

- **Functions:** Functions arguments, external, static and register variables, block structure initializations and recursion. Pointers: Pointers and functions, arrays, multidimensional arrays, pointers to array, array of pointers, initialization of pointers, command line arguments.
- **Structures:** Structures, arrays of structures, pointers to structure. Table look up, fields, union, type def. Preprocessors. Input - output - library of functions, formatted input, formatted output, file access line I/O. Unix system interface, file descriptors, low level I/O, read - write, open, create, close, unlink, random access.

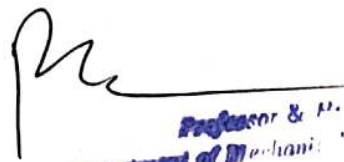
Text & Reference Books:

UNIX:

1. "Design of Unix O.S.", M. Bank, Tata McGraw Hill
2. "Programming of Unix", Kernighan & Pike, B. P. B.
3. "Advance Unix Programming", S. Plata, Tata McGraw Hill
4. "Unix O. S. (System-V)", Sumitava Das, Tata McGraw Hill

C-Programming:

1. *The Programming Language*, B. W. Kernighan & D. M. Ritchie, Prentice Hall, New Delhi
 2. *Data Structures using C*, A. M. Tenenbaun, Y. Laugsam & M. J. Augestein, Prentice Hall, New Delhi
 3. *Fundamentals of Data Structures in C*, E. Horowitz, S. Sahani & S. Anderson- Freed, Computer Science Press, New York.
 4. *Programming Languages: Design and Implementation*, Prentice Hall, New Delhi, Third Edition
 5. *Theory and Problems of Programming with C*, Byron S. Gottfried, Tata McGraw hill Publishing Co. Ltd, 1997.
-
1. *Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM* - Ray F. Egerton.


Professor & Head
Department of Mechanical Engineering
VIT-AP Institute of Technology
V.V.P.A., RAJACHANDRAPURAM, VISAKHAPATNAM - 5215

TCS - 7052 ARTIFICIAL INTELLIGENCE & INTELLIGENT SYSTEM

- **Introduction to Artificial Intelligence:** the AI problem, the underlying Assumption, what is an AI technique? The level of the model, criteria for success Problems, problem spaces and search: defining the problem as a state space search, production systems, problem characteristic, production system characteristic, issue in the Design of search problems.
- **Heuristic search techniques:** Generate-and -test, hill climbing, best-first-search, problem reduction, constraint satisfaction, means-ends-analysis.
- **Knowledge representation issues:** Representations and mappings, approaches to knowledge representation, issue in knowledge representation, the frame problem.
- **Using predicate logic:** Representing simple facts in logic, representing instance and Iso-relationships, computable function and predicates, resolution, natural deduction.
- **Representing knowledge using rules:** Procedural versus Declarative knowledge, logic programming, forward versus backward reasoning, matching, control knowledge.
- **Expert systems:** Representing and using Domain knowledge, expert system shells, explanation, knowledge acquisition.

Text & Reference Books:

1. Rich E., *Artificial Intelligence*
2. Charniak E., *Introduction of Artificial Intelligence.*
3. Marcellus, *Expert System Programming in TURBO PROLOG.*

MEE - 2001 SOFT COMPUTING TECHNIQUES

- **Introduction:** Structural and Foundation of Single Neutron, Neutral Net Architectures, Neutral Learning Application, Evaluation of Networks, Implementation.
- **Supervised Learning:** Single layers Networks, Perceptions, Linear Separability, Perception, Training Algorithms, Guarantee of Success, Modification.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

- **Multilayer Network:** Multilevel Discrimination, Preliminaries, Back-propagation, Algorithm, Setting the Parameter Values, Accelerating the Learning Process, Application.
- **Unsupervised Learning:** Winner takes all the Networks, Learning Vectors Quantities, ART, Topologically Organized Networks.
- **Associate Models:** Non-Iterative Procedures for Association, Hop field Networks, Brain State in a Box Network, BAM, Boltzmann Machines.
- **Optimization Methods:** Optimization using Hopfield Networks, Evolutionary Computation. Discussion of Neutral Networks Application: Areas of Pattern Recognition, Control and Time Series Prediction.

Text & Reference Books:

1. *"Elements of Artificial Neural Networks"*, Krishan Mehrotra, Chilakuri K. Mohan and Sanjay Ranka, Pervam Publishing International publishing (India).
2. *"Neural Networks: A Comprehensive Foundation"*, Siman Haykin, IEEE, Press, Macmillan, N.Y., 1994.



BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI
NEWCOURSE STRUCTURE - To be effective from academic session 2018- 19
Based on CBCS & OBE model
Recommended scheme of study for all M.Tech in Computer Aided Analysis and Design

| SEMESTER / Session of Study (Recommended) | Course Level | Category of course | Course Code | Courses | Mode of delivery & credits L-Lecture; T-Tutorial; P- Practicals | | | Total Credits C- Credits | |
|---|--------------|---|-------------|--|---|-------------------------|-------------------------|--------------------------------|-----------|
| | | | | | L (Periods/ week) | T (Periods/ week) | P (Periods/ week) | C | |
| FIRST / Monsoon | FIFTH | THEORY | | | | | | | |
| | | Programme Core (PC) | ME501 | Computational Methods in Engineering | 3 | 0 | 0 | 3 | |
| | | | ME502 | Advanced Computer Aided Design | 3 | 0 | 0 | 3 | |
| | | | ME503 | Advanced Stress Analysis | 3 | 0 | 0 | 3 | |
| | | Programme Elective (PE)*(* Student can choose only one of these) | ME504 | Computational Fluid Dynamics | 3 | 0 | 0 | 3 | |
| | | | ME505 | Mechatronics | 3 | 0 | 0 | 3 | |
| | | | ME506 | Applied Tribology | 3 | 0 | 0 | 3 | |
| | | Open elective OE | | Open Elective (OE) 1 | 3 | 0 | 0 | 3 | |
| | | LABORATORIES | | | | | | | |
| | | Programme Core (PC) | ME508 | Computer Programming and Simulation Lab | 0 | 0 | 4 | 2 | |
| | | | ME509 | Computer aided Analysis Lab | 0 | 0 | 4 | 2 | |
| | | TOTAL | | | | | | | 19 |
| | | SECOND/ Spring | FIFTH | THEORY | | | | | |
| Programme Core (PC) | ME510 | | | Advanced Vibration & Simulation | 3 | 0 | 0 | 3 | |
| | ME511 | | | Finite Element Analysis | 3 | 0 | 0 | 3 | |
| | ME512 | | | Reverse Engineering and Rapid Prototyping | 3 | 0 | 0 | 3 | |
| Programme Elective (PE)*(* Student can choose only one of these) | ME513 | | | Continuum Mechanics | 3 | 0 | 0 | 3 | |
| | ME514 | | | Design Against Fatigue and Failure | 3 | 0 | 0 | 3 | |
| | ME515 | | | Computer Integrated Manufacturing | 3 | 0 | 0 | 3 | |
| Open elective OE | | | | Open Elective (OE) 2 | 3 | 0 | 0 | 3 | |
| LABORATORIES | | | | | | | | | |
| Programme Core (PC) | ME516 | | | Advanced CAD & RE Lab | 0 | 0 | 4 | 2 | |
| | ME517 | | | Finite Element Analysis Lab | 0 | 0 | 4 | 2 | |
| TOTAL FOR FIFTH LEVEL | | | | | | | 19 | | |
| TOTAL | | | | | | | 38 | | |
| THEORY | | | | | | | | | |

PPK
Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

| | | | | | | | | | |
|---|-------|---|-------|---|---|---|---|----|--|
| THIRD / Monsoon | SIXTH | Programme Core (PC) | ME600 | Thesis Part I | | | | 8 | |
| | | | ME602 | Optimization Techniques | 3 | 0 | 0 | 3 | |
| | | Programme Elective (PE)* <i>Student can choose only one of these</i> | ME603 | Soft Computational Techniques in Design | 3 | 0 | 0 | 3 | |
| | | | ME604 | Computer Graphics | 3 | 0 | 0 | 3 | |
| | | | ME605 | Additive Manufacturing | 3 | 0 | 0 | 3 | |
| | | LABORATORIES | | | | | | | |
| | | Programme Core (PC) | ME606 | Optimization Techniques Lab | 0 | 0 | 4 | 2 | |
| | | TOTAL | | | | | | | |
| | | 16 | | | | | | | |
| | | FOURTH/ Spring | SIXTH | THEORY | | | | | |
| Programme Core (PC) | ME650 | | | Thesis Part II | | | | 16 | |
| TOTAL | | | | | | | | | |
| 16 | | | | | | | | | |
| TOTAL FOR SIXTH LEVEL | | | | | | | | | |
| 32 | | | | | | | | | |
| GRAND TOTAL FOR M.TECH PROGRAMME (38 + 32) | | | | | | | | | |
| 70 | | | | | | | | | |


 Professor & Head
 Department of Mechanical Engineering
 Birsa Institute of Technology
 MESRA, RANCHI-835215

**DEPARTMENT OF MECHANICAL ENGINEERING
PROGRAMME ELECTIVES (PE) CAAD
OFFERED FOR LEVEL 5-6**

| PE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|--|----------|---|---------------------------------|---|---|---|---|
| 5 | ME504 | Computational Fluid Dynamics | NIL | 3 | 0 | 0 | 3 |
| | ME505 | Mechatronics | NIL | 3 | 0 | 0 | 3 |
| | ME506 | Applied Tribology | NIL | 3 | 0 | 0 | 3 |
| | ME513 | Continuum Mechanics | NIL | 3 | 0 | 0 | 3 |
| | ME514 | Design Against Fatigue and Failure | NIL | 3 | 0 | 0 | 3 |
| | ME515 | Computer Integrated Manufacturing | NIL | 3 | 0 | 0 | 3 |
| 6 | ME603 | Soft Computational Techniques in Design | NIL | 3 | 0 | 0 | 3 |
| | ME604 | Computer Graphics | NIL | 3 | 0 | 0 | 3 |
| | ME605 | Additive Manufacturing | NIL | 3 | 0 | 0 | 3 |
| * PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE DEPARTMENT STUDENTS | | | | | | | |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

DEPARTMENT OF MECHANICAL ENGINEERING
OPEN ELECTIVES (OE)*
OFFERED FOR LEVEL 5-6

| OE / LEVEL | Code no. | Name of the PE courses | Prerequisites courses with code | L | T | P | C |
|-------------------|-----------------|-------------------------------|--|----------|----------|----------|----------|
| 5 | ME582 | Design Methodology | NIL | 3 | 0 | 0 | 3 |
| | ME583 | Renewable Source of Energy | NIL | 3 | 0 | 0 | 3 |
| | ME584 | Energy Management & Auditing | NIL | 3 | 0 | 0 | 3 |
| | ME585 | Industrial Robotics | NIL | 3 | 0 | 0 | 3 |
| | ME586 | Reliability in Design | NIL | 3 | 0 | 0 | 3 |

*** OPEN ELECTIVES TO BE OPTED ONLY BY OTHER DEPARTMENT STUDENTS**





Department of Mechanical Engineering **Birla Institute of Technology, Mesra, Ranchi - 835215 (India)**

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

To educate students at Undergraduate, Post Graduate, Doctoral, and Post Doctoral levels to perform challenging engineering and managerial jobs in industry.

- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

To become an internationally recognized Centre of excellence in academics, research and technological services in the area of Mechanical Engineering and related interdisciplinary fields.

Department Mission

- Imparting strong fundamental concepts to students and motivate them to find innovative solutions to engineering problems independently
- Developing engineers with managerial attributes capable of applying latest technology with responsibility
- Creation of congenial atmosphere and excellent research facilities for undertaking quality research by faculty and students
- To strive for more internationally recognized publication of research papers, books and to obtain patent and copyrights
- To provide excellent technological services to industry.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

Programme Educational Objectives (PEOs) – Computer Aided Analysis and Design

PEO 1: To prepare post graduates who will have strong fundamentals of computer aided design and modern computational techniques for analysing and improving mechanical equipment.

PEO 2: To prepare post graduates who will be competent enough to work successfully in challenging industrial environment.

PEO 3: To possess wisdom regarding group dynamics to efficaciously utilize opportunities for positive contribution to collaborative multidisciplinary engineering research and rational analysis to manage projects economically.

PEO 4: To communicate with engineering community and society at large adhering to relevant safety regulations as well as quality standards.

PEO 5: To inculcate the ability for life-long learning to acquire professional and intellectual integrity, ethics of scholarship and to reflect on individual action for corrective measures to prepare for leading edge position in industry, academia and research institutes.

PROGRAM OUTCOMES (POs)

M. Tech. in Mechanical Engineering (Computer Aided Analysis and Design)


PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Recognize the need for continuous learning and will prepare one to create, select and apply appropriate techniques and modern engineering and IT tools to solve complex control system problems.

PO5: Demonstrate knowledge of engineering and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society.


Prof. Dr. R. S. Sood
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME521

Course title: Computational Methods in Engineering

Pre-requisite(s): Mathematics course of UG level

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Learn different numerical techniques for solving problems in linear algebra, differential and integral calculus. |
| 2. | Apply numerical methods for solving engineering problems. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand several numerical techniques used in linear algebra. |
| CO2. | Solve systems of linear and nonlinear algebraic equations encountered in engineering problems. |
| CO3. | Evaluate differentiation and integration using different numerical techniques. |
| CO4. | Solve ordinary and partial differential equations using numerical methods |
| CO5. | Create new ideas in engineering computations. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Numerical Methods in Linear Algebra: Direct and iterative solution techniques for simultaneous linear algebraic equations – Gauss elimination, Gauss – Jordan, LU and QR decomposition, Jacobi and Gauss-Seidel methods, Eigenvalues and Eigenvectors – Power and inverse power method, physical interpretation of eigen values and eigenvectors, householder transformation. (8L)

Module 2:

Solution of nonlinear algebraic equations: Bisection method, fixed-point iteration method, Newton – Raphson, Secant method. Interpolation: Polynomial interpolation, Lagrange interpolating polynomial, Hermite interpolation, interpolation in two and three dimensions. (7L)

Module 3:

Numerical differentiation and Integration: Finite difference formula using Taylor series, Differentiation of Lagrange polynomials, Simpson's rule, Gauss – quadrature rule, Romberg method, multiple integral. (9L)

Module 4:

Numerical solutions of ordinary differential equations: Euler's method, Heun's method and stability criterion, second and fourth order Runge-Kutta methods, Adams – Bashforth – Moulton method, system of ODEs and nonlinear ODEs. (10L)

Module 5:

Partial Differential Equations: Classifications of PDEs, Elliptic equations, Parabolic equations, Hyperbolic equations (wave equation). (6L)

Text Books

1. Joe D Hoffman, Numerical Methods for Engineer and Scientists, Marcel Dekker.
2. S. P. Venkateshan and P. Swaminathan, Computational Methods in Engineering, Ane books.

Reference Books

1. Gilbert Strang, Computational Science and Engineering, Wessley – Cambridge press.
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata Mc Graw Hill.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RAIPUR-831015

COURSE INFORMATION SHEET

Course code: ME502

Course title: Advanced Computer Aided Design

Pre-requisite(s): Computer aided Design, Machine Design

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand the transformation techniques and solid modelling. |
| 2. | Generate the Synthetic Curves. |
| 3. | Develop programs for design and drawing of Machine Elements. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the concept of solid modeling and transformation techniques. |
| CO2. | Understand how to transfer data in CAD system. |
| CO3. | Apply the knowledge to generate surface patches, synthetic surfaces. |
| CO4. | Understand how to generate different curves. |
| CO5. | Apply the knowledge to develop programs for design and drawing of Machine Elements. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RAIPUR

SYLLABUS

Module 1:

Review of 2D representation in CAD Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 3D; Projections; Introduction to assembly modelling, IGES, STEP & DXF data exchange format. (8L)

Module 2:

Representation of surface patches; Analytic surfaces; Synthetic surfaces; Surface modelling; Solid entities; CSG approach of solid modelling; Boolean operations; B-rep approach of Solid Modelling; Boundary evaluation technique. (8L)

Module 3:

Synthetic Curves: Concept of continuity, cubic spline curve, Bezier curve, B-Spline curve and NURBS. (8L)

Module 4:

Animation and Collaborative Design: Mechanism and Animation, Collaborative Design Principles, Approaches, Tools, Design Systems. (8L)

Module 5:

Development of programs for design and drawing of Machine Elements: Shafts, Gears, Pulleys, Flywheel, Connecting rods. (8L)

Text Books

1. Mastering CAD/CAM by Ibrahim Zeid, Tata McGraw-Hill
2. Computer Graphics by Donald Hearn and M. Pauline Baker, Prentice Hall of India Pvt. Ltd. Delhi

Reference Books

1. CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw-Hill
2. CAD/CAM: Computer Aided design and Manufacturing by Mikell Groover and Zimmer, Pearson Education

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

Gaps in the syllabus (to meet Industry/Profession requirements) :

Computer graphics.

POs met through Gaps in the Syllabus: PO1 to PO5


Professor & Head
Department of Mechanical Engineering
B.T. Institute of Technology
RANIBELUR

COURSE INFORMATION SHEET

Course code: ME503

Course title: Advanced Stress Analysis

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P:0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Get familiar with the fundamentals of solid mechanics. |
| 2. | Understand mathematical formulations of solid mechanics problems. |
| 3. | Explain the theories of failure and basic of plasticity. |
| 4. | Solve the advanced problems in torsion, plates and shells. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the fundamentals of 2D and 3D stresses. |
| CO2. | Analyse 2D and 3D advanced solid mechanics problems of strains. |
| CO3. | Understand the fundamentals of theories of failure and basic equations of plasticity. |
| CO4. | Evaluate stress functions in Cartesian and polar coordinate systems to solve stresses in advanced solid mechanics. |
| CO5. | Apply the concepts of solid mechanics to solve torsion, plate and shell problems. |



Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
UPESKA, RAIPUR

SYLLABUS

Module 1:

Components of stress at a point; Tensorial character; Cauchy's stress relations; Principal stresses and stress invariants; Octahedral stress components; Homogeneous and deviatoric stress components; Equilibrium equations; Boundary conditions. (7L)

Module 2:

Components of strain at a point; Tensorial character; Principal strains and strain invariants; Strain-displacement relations; Compatibility conditions; Generalized Hooke's law; Engineering and Lemi's elastic constants; Plane stress and plane strain problems; Biharmonic equation. (7L)

Module 3:

Yield criteria; Stress space; Tresca's and Von-Mises' theories of failure; Yield curves on π -plane; Analysis of fundamental equation of plasticity; The equation of plasticity for a plain strain; The influence of the mean stress on the shear strength; Characteristics and slip lines as a method of determining stresses; Properties of slip lines. (6L)

Module 4:


Principle of superposition; Uniqueness theorem; St. Venant's principle; Stress function; Plane problems in Cartesian coordinates; Solutions by polynomials; Plane problems in polar coordinates; Complex stress functions. (10L)

Module 5:

Applications – Torsion of bars: Saint-Venant's free torsion; Torsion of circular, elliptical and rectangular sections; Membrane analogy. Bending of plates: Variation of stress within a plate; The governing equation for plate deflection; Strain energy of plates. Shells: Symmetrically loaded shells of revolution; Strain energy in bending and stretching of shells; Axi-symmetrically loaded circular cylindrical shells. (8L)

Text Books

1. L.S. Srinath, Advanced Mechanics of Solids, 3rd Ed. Tata McGraw-Hills Publishing Company Ltd., 2008.
2. S.P. Timoshenko, J.N. Goodier, Theory of Elasticity, 3rd Ed., McGraw-Hill Book Company, 1970.
3. A.C. Ugural, Stresses in Beams, Plates, and Shells, 3rd Ed., CRC Press, 2009.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME504

Course title: Computational Fluid Dynamics

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Get familiar with the fundamentals of CFD. |
| 2. | Understand various mathematical techniques used in CFD. |
| 3. | Develop the ability to formulate the problems and apply appropriate numerical schemes. |
| 4. | Understand the difference as well as suitability to apply the RANS and scale resolving approach. |
| 5. | Implement the concepts using simple CFD codes. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the fundamentals of CFD. |
| CO2. | Develop an intuitive understanding of the CFD techniques. |
| CO3. | Understand the fundamentals of turbulence modelling. |
| CO4. | Learn fundamentals on the near-wall modelling approach. |
| CO5. | Apply the CFD concepts on real-world problems. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
BESRA, RANCHI-835 215

SYLLABUS

Module 1:

Introduction to CFD; Conservative and non-conservative forms of the continuity equation, momentum equation and energy equation; Types of boundary conditions and description about standard test cases; Burger's equations. (7L)

Module 2:

Mathematical behaviour of PDE: Nature of coordinates, Classification of quasi-linear PDE – hyperbolic, parabolic, elliptical equations. CFD techniques: Discretization of governing equations – finite difference method, finite volume method, finite element method, spectral method; temporal discretization. (8L)

Module 3:

CFD techniques: Converting governing equations to algebraic equation system; Steady one-dimensional convection and diffusion; Direct methods to solve algebraic equations: Gaussian elimination, forward elimination process, Thomas algorithm; Iterative methods to solve algebraic equations: Jacobi and Gauss-Seidel methods; Pressure-velocity coupling – SIMPLE and SIMPLEC scheme. (10L)

Module 4:

Turbulent-flow modelling: The physics of fluid turbulence – the Kolmogorov hypothesis, energy cascade, turbulent energy spectrum; Turbulence modelling: Direct numerical simulation, Large-eddy simulations, Reynolds decomposition, models based on the turbulent viscosity hypothesis; Near-wall modelling; Inlet and outlet boundary conditions. (8L)

Module 5:

Best practice guidelines: Application uncertainty; Numerical uncertainty – convergence, enhancing convergence, numerical errors; Numerical stability. (7L)

Text Books

1. J.D. Anderson, Jr., Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, Inc., 1995.
2. B. Andersson, R. Andersson, L. Kansson, M. Mortensen, R. Sudiyo, B.V. Wachem, Computational Fluid Dynamics for Engineers, Cambridge University Press, 2012.
3. J. Tu, G.H. Yeoh, C. Liu, Computational Fluid Dynamics: A Practical Approach, 2nd Ed., Elsevier, 2015.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME505

Course title: Mechatronics

Pre-requisite(s): Basic Electronics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand the basics of Mechatronics, sensors and actuators |
| 2. | Analyse various actuation systems, and enable to understand the basic concept of motors |
| 3. | Develop system models and control systems for new developed equipments and applications |
| 4. | Analyse and deal with the programmable logic controllers and circuits |
| 5. | Develop new models and concepts, understand the new technology and usage. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Analyse mechatronic systems and automated systems |
| CO2. | Apply sensors and controllers in the circuit |
| CO3. | Apply actuation system and drives to the new developed mechatronic system |
| CO4. | Analyse various programmable logic controllers and microcontrollers |
| CO5. | Develop and predict for the performance for various new systems, robotic systems and possible design solutions |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction and Overview: Introduction to Mechatronics, Mechatronics in product design and system control, Sensors and Transducers, displacement, pressure, temperature, optical, piezoelectric, strain gauge, Review of fundamentals of electronics. Data conversion devices, micro-sensors, signal processing devices, Relay. (9L)

Module 2:

Actuation systems Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems, hydraulic, pneumatic drives. (9L)

Module 3:

System models and controllers Microprocessors, Description of PID controllers. CNC machines and part programming, adaptive control, Flexible manufacturing systems. (8L)

Module 4:

Programmable Logic Controllers (PLC)- input and output processing and programming, timers, internal relays and controllers, shift resistor, Ladder programming, converters. (8L)

Module 5:

Stages in designing, Mechatronic Systems, Traditional and Mechatronics design, Case studies of Mechatronics systems, Pick and place robot, Autonomous mobile robot, wireless surveillance, balloon engine management, car parking barrier systems, Design for manufacture and assembly. (6L)

Text Books

1. HMT Ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. Introduction to Mechatronics and Measurement System by David G. Alciatore, Michael B. Histamd, Mc Graw Hill
3. Mechatronics by Bolton, Pearson Education

Reference Books

1. Mechatronics System Design by Devdas and Shetty, Pearson Education

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME506
Course title: Applied Tribology
Pre-requisite(s): Industrial Tribology
Co- requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M. Tech
Semester / Level: I/05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Comprehend the concept of tribology for applying lubrication in bearings and other machine elements |
| 2. | Design the tribological systems consisting bearings |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the basic concepts of friction, wear, and lubrication |
| CO2. | Apply the knowledge of surface texture parameters for selection of bearing materials |
| CO3. | Write Reynold's equation for various bearing problems and design thrust bearings |
| CO4. | Design journal bearings and squeeze-film bearings |
| CO5. | Design hydrostatic and rolling element bearings |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
RAJCHANDRA, RANCHI-835215

SYLLABUS

Module 1:

Friction, Wear, and Lubrication, Tribology principles, Principles for selection of bearing types, Lubricants and Lubrication, Mineral oils, Synthetic oils, Viscosity, Density and compressibility, Thermal Properties, Oil life, Greases, Solid lubricants, Lubricant supply methods. (6L)

Module 2:

Surface Texture and Interactions, Geometric characterization of surfaces, Surface parameters, Measurement of surface texture, Measurement of surface flatness, Statistical descriptions, Contact between surfaces, Lubrication regime relation to surface roughness, Bearing Materials, Distinctive selection factors, Oil-film bearing materials, Dry and semi-lubricated bearing materials, Air bearing materials, High-temperature materials, Rolling bearing materials. (8L)

Module 3:

Fundamentals of Viscous Flow, Conservation of mass, momentum, and energy, non-dimensionalisation, Reynolds Equation and Applications, Performance parameters, Thrust Bearings, Thrust bearing types, Design factors, Performance analysis, Design procedure. (7L)

Module 4:

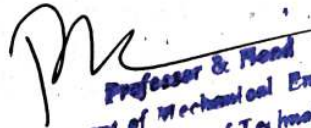
Journal Bearings, Full-arc plain journal bearing with infinitely long approximation, Boundary conditions, Definition of the Sommerfeld number, Cavitation phenomena, Bearing performance parameters, Finite journal bearing design and analysis, Bearing Stiffness, Rotor Vibration, and Oil-Whirl Instability, General design guides, Squeeze-Film Bearings, Governing equations, Planar squeeze film, Non-planar squeeze film, Squeeze film of finite surfaces, Piston rings. (10L)

Module 5:

Hydrostatic Bearings, Types and configurations, Circular step thrust bearings, Capillary-compensated hydrostatic bearings, Orifice-compensated bearings, Design procedure for compensated bearings, Hydraulic lift, Rolling Element Bearings, Ball bearing types, Roller bearing types, Thrust bearing types, Load-life relations, Adjusted rating life, Static load capacity. (9L)

Text Books

1. M. M. Khonsari and E. R. Booser. Applied Tribology: Bearing Design and Lubrication, Second Edition. John Wiley & Sons, Ltd, 2008.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESKA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME508

Course title: Computer Programming & Simulation Lab

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand the concept of programming and simulation in MATLAB. |
| 2. | Enhance their analysing and problem solving skills using computational simulation techniques. |

Course Outcomes

At the end of this course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the concept of programming using computer language. |
| CO2. | Understand the concept of computer simulation. |
| CO3. | Analyse design problems using programming. |
| CO4. | Apply the computer programming and simulation in control systems. |
| CO5. | Apply the knowledge of MATLAB programming and simulation in soft computational techniques. |

List of Experiments

Experiment 1: Introduction to MATLAB.

Experiment 2: Matrix operations and polynomials.

Experiment 3: MATLAB graphics.

Experiment 4: Programming with loops and functions in M file.

Experiment 5: Solution of differential equations and symbolic mathematics

Experiment 6: Applications of MATLAB commands to vibration engineering problems.

Experiment 7: Applications of MATLAB commands and graphics to solve computer aided design problems

Experiment 8: Introduction to Simulink.

Experiment 9: State space modelling of engineering systems and solution in Simulink.

Experiment 10: Simulation of non-linear systems.

 Professor & Head
Department of Mechanical Engineering
B.T. Institute of Technology
MANGALURU

27

Experiment 11: MATLAB applications in control systems

Experiment 12: MATLAB applications soft computational techniques..

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

| CO | PO1 | PO2 | PO3 | PO4 | PO5 |
|-----|-----|-----|-----|-----|-----|
| CO1 | 3 | 3 | 3 | 2 | 1 |
| CO2 | 3 | 2 | 2 | 2 | 1 |
| CO3 | 3 | 1 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 3 | 1 | 2 |
| CO5 | 2 | 3 | 3 | 2 | 1 |

< 34% = 1, 34-66% = 2, > 66% = 3

M
Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME509

Course title: Computer Aided Analysis Lab.

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: I/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Understand the concepts of simulation using ANSYS Mechanical and Fluent |
| 2. | Enhance their analysing and problem-solving skills using computational techniques. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand and apply the numerical techniques via computer simulations. |
| CO2. | Identify the problem and generate suitable mesh. |
| CO3. | Import mesh file into the solver and apply appropriate boundary conditions. |
| CO4. | Run the solver with pre-defined user settings. |
| CO5. | Extract the results in the form of graphs and plots from the solver or by making use of the post-processing tools and analysing them. |

List of Experiments

Experiment 1: Application of 1D element to analyse beam and truss structures under point and distributed static loadings.

Experiment 2: Application of 2D element to analyse plate structure.

Experiment 3: Application of 3D element to analyse 3D objects.

Experiment 4: Modal Analysis of structures to detect natural frequencies and mode shapes.

Experiment 5: Harmonic Analysis of structures.

Experiment 6: Transient analysis of structures.

Experiment 7: Fluid flow and heat transfer in a mixing elbow/heat exchanger.


Experiment 8: Modelling external compressible flow.

Experiment 9: Modelling flow through porous media.

Experiment 10: Using the VOF model.

Experiment 11: Modelling flow inside Cyclone separators.

Experiment 12: Multiphase flow problem.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215 30

COURSE INFORMATION SHEET

Course code: ME510

Course title: Advanced Vibration & Simulation

Pre-requisite(s): Engineering mechanics, Strength of Material

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Understand the advanced multi degrees of freedom system analysis techniques. |
| 2. | Analyse non-linear vibration systems. |
| 3. | Analyse the signatures of vibrating systems and detect the faults. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Understand the concept of modeling and simulation of vibrating systems. |
| CO2. | Analyse multi degrees of freedom and continuous systems. |
| CO3. | Evaluate the natural frequencies and mode shapes of vibrating systems. |
| CO4. | Analyse nonlinear vibrating systems. |
| CO5. | Apply the knowledge of vibration to detects the faults of machineries and take preventive maintenance. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Review of free and forced vibration analysis of single degree of freedom system with and without damping; Transient vibration; rotor unbalance; whirling of rotating shaft; Torsional vibration; state-space modelling of single degree of freedom system; Introduction to vibration simulation software. (8L)

Module 2:

Vibration analysis of two and multi degrees of freedom system; matrix formulation; influence coefficient; flexibility matrix; stiffness matrix; coordinate coupling; Vibration analysis of continuous systems: Lateral vibration of string, Longitudinal vibration of bar, Torsional vibration of uniform shaft, Transverse vibration of beams; state space modelling of multi degrees of freedom system; Utilization of finite element method in simulation of continuous systems (8L)

Module 3:

Determination of natural frequencies and mode shapes of multi degrees of freedom system; Eigen values and Eigenvectors; Approximate methods: Dunkerley's method, Holzer's method, Stodola's method, Rayleigh-Ritz method, Method of matrix iteration; Modal analysis using simulation tools (8L)

Module 4:

Introduction to Nonlinear Vibration: Commonly observed nonlinear phenomena; Development of nonlinear governing equation of motion of Mechanical systems; linearization techniques; commonly used nonlinear equations: Duffing equation, Van der Pol's equation, Mathieu's and Hill's equations; Different Approximate solution methods; Simulation of non-linear systems. (8L)

Module 5:

Application of vibration: Vibration measuring Instruments; Vibration exciters; Vibration analysers; time domain and frequency domain vibration analysis; Signature analysis of vibrating systems; Machinery faults detections using vibration analysis (crack detection, bearing faults detections) (8L)

Text Books

1. Advanced Theory of Vibration by J.S.Rao, New Age International Publishers.
2. Nonlinear Oscillations by A.H.Nayfeh and D.T. Mook, Wiley-Interscience


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME511

Course title: Finite Element Analysis

Pre-requisite(s): Engineering Mathematics, Fundamentals of Programming Language, Mechanics of materials, Thermodynamics

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand the basic concepts and procedures in finite element analysis. |
| 2. | Analyze different types of mechanics problems in engineering using the finite element method. |
| 3. | Have proficiency in the application of the finite element method. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Obtain an understanding of the fundamental theory of the FEA method. |
| CO2. | Develop the ability to generate the governing FE equations for systems governed by partial differential equations. |
| CO3. | Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements. |
| CO4. | Ability to evaluate and interpret FEA analysis results for design and evaluation Purposes. |
| CO5. | Apply and use of the FE method for heat transfer problems. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Overview of Engineering systems

Continuous and discrete systems (discussion on differential equations, matrix algebra), steady state, propagation and eigen value problems. (8L)

Module 2: Energy methods

Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, Rayleigh-Ritz Formulation, development of bar and beam element, application to truss and frames. (8L)

Module 3: Finite elements for two-dimensions

Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions (Lagrangian and Hermite) in physical coordinates. (8L)

Module 4: Iso-parameteric mapping

Iso-parameteric mapping, numerical integration, Assembly procedure, solution techniques, Jacobian matrix. Numerical integration – 2 and 3 point Gauss Quadrature, full and reduced integration. Sub-modeling, sub-structuring, introduction to finite element programming. (8L)

Module 5: Case study

Torsion of prismatic bars, modal analysis; direct integration methods for dynamic analysis; contact analysis, applications to problems in engineering: plane elasticity, heat conduction, potential flow and Transient problems. Computer implementation. (8L)

Text Books

1. Chandrupatla T . R., and Belegundu, A. D., Introduction to Finite Elements in Engineering, Prentice Hall, 2003.
2. Reddy, J. N., An Introduction to the Finite Element Method, 3rd Edition, McGraw-Hill Science/Engineering/Math, 2005.
3. Bhatti, M.A., Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations, Wiley, 2005.

Reference Books

1. Bathe, K-J., Finite Element Procedures, Prentice Hall, 1996.
2. Logan D. L., A First Course in the Finite Element Method, Thomson- Engineering, 3rd edition, 2001.
3. Zienkiewicz, O.C. and Taylor, R.L., The Finite Element Method, 6th Ed., Vol. 1, Elsevier, 2005.

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME512

Course title: Reverse Engineering and Rapid prototyping

Pre-requisite(s): CAD

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Develop a comprehensive and better designing for an engineering perspective and change from an older design to newer. |
| 2. | Lay the foundation for subsequent studies in conventional and nonconventional product development phases and to prepare the students to effectively use it in the practice of engineering. |
| 3. | Develop an intuitive understanding of why and how to reverse engineer an older product to new concept and design its improvements. |
| 4. | Understand CAD CAE and RP tools and to redraw a circuit with new amendments |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Explain the Reverse engineering methodology. |
| CO2. | Examine the disassembled parts with concern to its functionality |
| CO3. | Choose the different types of RE systems |
| CO4. | Analyze the basics of RP processes and their advantages. |
| CO5. | Adapt RE and RP processes in basic design |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Basic concepts in reverse engineering

Introduction to RE forward engineering, reverse engineering, value engineering, design thought and process, design step, mechatronics system design The problem what is Reverse Engineering The RE process, Technical Data Development, Benefits of RE, RE as a Quality function, Uses of RE, Value Engineering and RE, Origin of RE, legal issues, Patent Infringement and Theft. (8L)

Module 2: Reverse engineering methodology

RE steps, system level design and examples, product development, product function, product teardown, engineering specification, product architecture visual and Dimensional inspection, comparison to technical data, Disassembly and assembly procedures, material analysis, Technical data generation, Developing engineering drawings, Dimensional accuracy ,technical data package completed, Design verification prototype determination prototype failure and retesting, Inspection criteria, Project Implementation. (8L)

Module 3: Scanning devices

Reverse Engineering and CAD interface, Scanners , Contact type, Non-contact type, Coordinate measuring Devices, 3D scanning white light scanners, Cloud data scanning, Processing, Surface recreation, 3D modeling, Final model development, Digital representation for communication of Product development. (8L)

Module 4: Introduction to Rapid prototyping

Prototyping fundamentals, Historic development, advantages and disadvantages, Limitations of RP, Classification of RP Liquid Based Prototyping, Stereo lithography (SLA), methods, principle, specifications and areas of application, Solid Based RP systems, (SGC), FDM Fused Deposition Modeling, SLS Selective Laser Sintering, 3D Printing. (8L)

Module 5: RE in design

Design of new products, R.E. in computer application, Reverse engineering of PLC programmes. Rapid Tooling, aerospace, automotive, Basic design procedures for implementing RE medical and bioengineering, customized implants and prosthetics, forensic science and anthropology. RE and RP interrelation, Case studies. (8L)

Text Books

1. Reverse Engineering by Kathryn A. Ingle , McGraw Hill 1994.
2. Rapid prototyping Principles and Application by Rafiq, Nooraani , Wiley and Sons


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME513

Course title: Continuum Mechanics

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Get familiar with the fundamentals of continua. |
| 2. | Work on using the lower and higher rank tensors. |
| 3. | Understand various mathematical techniques used in continuum mechanics. |
| 4. | Develop the ability to formulate the problems based on continuum approach. |
| 5. | Implement the concepts in wide variety of practical problems. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the fundamentals of continuum mechanics. |
| CO2. | Understand the fundamentals of vectors and tensors. |
| CO3. | Develop an intuitive understanding of the advanced mathematical techniques. |
| CO4. | Be familiar with the situations to treat the medium as continuous and its advantages. |
| CO5. | Apply the concepts of continuum mechanics on real-world problems both in solid and fluid mediums. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Fundamentals of Continuum Mechanics

Continuum Hypothesis; Tensors – Index notation and summation convention; Quotient rule; Inner products; Transformation law for Cartesian components of a tensor; Symmetric and Anti-symmetric tensors; Principal values and Principal directions of a tensor. Tensor Calculus – The del operator; Gradient, divergence, curl and Laplacian. Curvilinear coordinates – Polar, Cylindrical and Spherical coordinates. (7L)

Module 2: Kinematics of a Continuum

Bodies and their configurations; Deformation and configuration; Engineering strains; General kinematics of a solid continuum; Deformation – Pure dilatation, simple extension, simple shear, nonhomogeneous deformation; Green strain tensor; Infinitesimal strain tensor; Principal values and principal planes of strains. (7L)

Module 3: Conservation of Mass, Momentum and Energy

Conservation of mass – conservation of mass in spatial, and material description, Reynolds transport theorem; Conservation of momenta – principle of conservation of linear, and angular momentum; Thermodynamic principles – energy equations for 1-D flows, and a 3-D continuum. (9L)

Module 4: Linear constitutive equations

Constitutive equations and ideal materials; Material symmetry; Linear elasticity; Newtonian viscous fluids; Linear viscoelasticity; Heat transfer. (7L)

Module 5: Applications

Heat transfer – analytical solutions of 1-D and 2-D heat transfer, axisymmetric heat conduction in a circular cylinder; Fluid mechanics – inviscid fluid statics, parallel flow, diffusion process; Solid mechanics – analysis of bars and beams, analysis of plane elasticity problems. (10L)

Text Books

1. J.N. Reddy, An Introduction to Continuum Mechanics, 2nd Ed., Cambridge University Press, 2013.
2. A.J.M. Spencer, Continuum Mechanics, Dover Publications Inc., 1980.

Reference Books

1. S. Nair, Introduction to Continuum Mechanics, Cambridge University Press, 2009. Fracture Mechanics - Fundamentals and Applications by T. L. Anderson, Taylor and Francis


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME514
Course title: Design Against Fatigue and Failure
Pre-requisite(s): Machine Design, Materials Technology
Co- requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: II /05
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Develop a knowledge of the effect of variable loading on the materials response and the origin of fatigue failure. |
| 2. | Design approach to fatigue - design for infinite life and finite life and to prepare the students to effectively use it in the practice of engineering. |
| 3. | Develop an intuitive understanding of why and how to incorporate Fracture mechanics and its importance in the real world |
| 4. | Get aware of Design of components against fatigue. |
| 5. | Know about the Testing of the component designed against fatigue and failure. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the fatigue failure and its application in real world. |
| CO2. | Know for the Design for fatigue and failure. |
| CO3. | Analyse different systems for Statistical and physical aspect of Fatigue behaviour. |
| CO4. | Emphasize on the phases in fatigue life and dislocation. |
| CO5. | Outline the Testing of the components designed against fatigue and failure. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Fatigue consideration in Design

Variable load - basic concept; load or stress variations- Cyclic stressing/straining - materials response and the origin of fatigue failure. Stress life relations; S-N curve-fatigue strength and endurance limit Factors influencing fatigue and endurance strength modification factors, Effect of stress concentration and fatigue stress concentration, Effect of mean stress - Goodman and Soderberg's relations Design approach to fatigue - design for infinite life and finite life. (8L)

Module 2: Statistical aspect of Fatigue Behaviour

Low cycle and high cycle fatigue – Coffin – Manson's relation – Transition life – cyclic strain hardening and softening – Analysis of load histories Cycle counting techniques - Cumulative damage Miner's theory Other theories. (8L)

Module 3: Physical aspects of Fatigue

Phase in fatigue life – Crack initiation – Crack growth – Final Fracture – Dislocations – fatigue fracture surfaces. (8L)

Module 4: Fracture Mechanics

Strength of cracked bodies – Potential energy and surface energy – Griffith's theory – Irwin – Orwin extension of Griffith's theory to ductile materials – stress analysis of "cracked bodies – Effect of thickness on fracture toughness – stress intensity factors for typical geometries. (8L)

Module 5: Fatigue Design and Testing

Types of fatigue tests-load controlled high cycle and strain controlled low cycle fatigue, Design problems based on fatigue and failure. (8L)

Text Books

1. Elements of fracture mechanics by Prasanth Kumar, Tata McGraw Hill, New Delhi
2. Fracture Mechanics for Modern Engineering Design by K. R.Y. Simha, Universities Press (India) Limited

Reference Books

1. Elementary Engineering Fracture Mechanics, D. Broek, Kluwer Academic Publishers, Dordrecht
2. Fundamentals of Fracture Mechanics by J. F. Knott, Butterworth & Co., Ltd., London
3. Fracture Mechanics - Fundamentals and Applications by T. L. Anderson, Taylor and Francis


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME515

Course title: Computer Integrated Manufacturing

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: II /05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Understand the basic knowledge and skills in the field of computer integrated manufacturing. |
| 2. | Apply the knowledge of design, production and manufacturing systems |
| 3. | Integrate manufacturing systems with computer . |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques |
| CO2. | Develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.. |
| CO3. | Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc, as they apply to factory management and factory floor operations. |
| CO4. | Describe the integration of manufacturing activities into a complete system |
| CO5. | Develop an FMS layout for given simple part family, using group technology concepts and familiarize with computer aided process planning |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Brief introduction to CAD and CAM, Manufacturing Planning and control, Introduction to CIM Concepts & scope of CIM, Nature & type of manufacturing system, Evolution, Benefits of CIM, Mathematical models of Production Performance, Basic Elements of an Automated system, Lean Production and Just-In Time Production (8L)

Module 2:

Numerical Controls, types, evolution of controllers, components of NC/CNC system, specification of CNC system, NC part programming, Programming for drilling, lathe and milling machine operations, Programmable Logic Controllers. (8L)

Module 3:

Group Technology, Part Families – Parts Classification and coding, benefits of group technology, Production flow analysis, Cellular Manufacturing, Quantitative analysis in Cellular Manufacturing. (8L)

Module 4:

Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of FMS, advantages of FMS, Automated material movement & AS/RS AGVS , RGV Manufacturing Cells, Cellular & Flexible manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Work piece Handling, FMS scheduling, sequencing. (8L)

Module 5:

Introduction, Industrial Robots, Robot physical Configuration, Basic Robot motions, Robotic Power sources, Sensors, Actuators, Transducer and Grippers, Technical features such as work volume, precision of movement, speed of movement, weight carrying capacity, Robot Accuracy and Repeatability, Robot applications & economics. (8L)

Text Books

1. Groover, M. P., Automation production systems, and computer integrated manufacturing, second edition, Prentice Hall of India, New Delhi, 2001.

Reference Books

1. Vajpayee, S. K., Principles of computer integrated manufacturing, Prentice Hall of India, New Delhi, 2005.

Course Evaluation:

Individual assignment, Seminar, Theory (Quiz and End semester) examinations

 Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MBSRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME516

Course title: Advanced CAD and Reverse Engineering Lab

Pre-requisite(s): CAD

Co- requisite(s): Nil

Credits: 2 **L:** 0 **T:** 0 **P:** 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: II/05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Understand various 2D and 3D Modeling techniques |
| 2. | Analyse reverse engineering technique and design attributes |
| 3. | Understand various software for curve fitting |
| 4. | Generate prototypes with various RP techniques |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Create 3D models and prepare a new design |
| CO2. | Analyse the cloud data points and to further process it |
| CO3. | Generate usable data after curve fitting and segmentation |
| CO4. | Produce rapid prototyped parts out of scanned data |
| CO5. | Generate new ideas and products for varied uses |

List of Experiments

Experiment 1: Review of 2-Dimensional drawing.

Experiment 2: Introduction to 3-Dimensional modelling (Part modelling)

Experiment 3: Introduction to assembly modelling and assembly of mechanical engineering components.


Experiment 4: Writing program for 2-D and 3-D transformation for Translation, Scaling, Rotation, Shearing and Reflection.

Experiment 5: To scan and gather the cloud data from the digitizer/ scanner.

Experiment 6: To convert the point cloud to a polygonal mode (Clean, smoothen and sculpt the required shape and memory).

Experiment 7: To draw or create curves on the mesh using automated tools such as feature detection.

Experiment 8: Fit the B Spline surfaces using surface fitting and editing tools.


Professor & Head
Department of Mechanical Engineering
57
Birla Institute of Technology
MESRA, RANCHI-835215

Experiment 9: Export the final fitted curves to a CAD package and generate tool paths for machining.

Experiment 10: Analysis and measurement of the dimensions of each component for a new design.

Experiment 11: Convert finally to .stl and pass the drawing to the Rapid Prototyping Machine.

Experiment 12: Analyse the final prototype with the initial prototype.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |


| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |


Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology,
 WILSON COLLEGE, RAIPUR-835215

COURSE INFORMATION SHEET

Course code: ME517

Course title: Finite Element Analysis Lab

Pre-requisite(s): Nil

Co-requisite(s): Nil

Credits: 2 L: 0 T: 0 P: 4

Class schedule per week: 04

Class: M.Tech.

Semester / Level: II / 05

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Understand and apply finite element technique to solve different problems. |
| 2. | Analyse stresses and deformations under various loading conditions. |
| 3. | Determine natural frequencies of structures. |
| 4. | Develop computer codes to solve problems using FEM technique. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Analyse finite element models of structures under different types of loads. |
| CO2. | Analyse the structures due to thermal loading. |
| CO3. | Evaluate the natural frequencies of structures. |
| CO4. | Analyse non-linear behavior of structures. |
| CO5. | Create finite element program for analysis of different structures. |

List of Experiments

Experiment 1: Stress and deflection analysis of beam due to self-weight.

Experiment 2: Stress and deflection analysis of fixed and overhanging beams.

Experiment 3: Stress and deflection analysis of simply supported beam with distributed loads.

Experiment 4: Stress analysis of rectangular plate with circular hole and determine the stress concentration factor.

Experiment 5: Thermal stress analysis in rectangular plate.

Experiment 6: Geometric Non-linear (*change in response due to large deformation*) analysis of beam.

Experiment 7: Program to solve force and stresses using link element in trusses.

Experiment 8: Program to solve deflection and stresses using beam element in cantilever beam using point load.

Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
ME, RA, RANGOLI-835215



Experiment 9: Program to solve deflection and stresses using beam element in simply supported beam using point load.

Experiment 10: Program to solve modal analysis of beam to find natural frequencies using beam element.

Experiment 11: Program to solve plate problems using 2D element.

Experiment 12: Program to solve shell problems using 2D element.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

| Assessment Tool | % Contribution during CO Assessment |
|--------------------------------|-------------------------------------|
| Continuous Internal Assessment | 60 |
| Semester End Examination | 40 |

| Continuous Internal Assessment | % Distribution |
|------------------------------------|----------------|
| Day to day performance & Lab files | 30 |
| Quiz (es) | 10 |
| Viva | 20 |

| Semester End Examination | % Distribution |
|------------------------------------|----------------|
| Examination Experiment Performance | 30 |
| Quiz | 10 |

| Assessment Components | CO1 | CO2 | CO3 | CO4 | CO5 |
|--------------------------------|-----|-----|-----|-----|-----|
| Continuous Internal Assessment | | | | | |
| Semester End Examination | | | | | |

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Course Delivery Methods

| | |
|-----|---|
| CD1 | Lecture by use of boards/LCD projectors/OHP projectors |
| CD2 | Assignments/Seminars |
| CD3 | Laboratory experiments/teaching aids |
| CD4 | Industrial/guest lectures |
| CD5 | Industrial visits/in-plant training |
| CD6 | Self- learning such as use of NPTEL materials and internets |
| CD7 | Simulation |


 61
 Professor & Head
 Department of Mechanical Engineering
 Birla Institute of Technology
 MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME600

Course title: Thesis Part I

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 8 **L:** **T:** **P:**

Class schedule per week:

Class: M.Tech.

Semester / Level: III/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME612

Course title: Optimization Techniques

Pre-requisite(s): Mathematics, Basics of operation research

Co- requisite(s): Nil

Credits: 3 **L:** 3 **T:** 0 **P:** 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|--|
| 1. | Formulate the different engineering optimization problems using the concept of optimization technique. |
| 2. | Develop basic concept of algorithm to solve the different engineering optimization problems. |
| 3. | Analyse and appreciate different algorithm methods in the field of optimization technique. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand and formulation of various engineering optimization problem. |
| CO2. | Analyze the single variable optimization algorithm. |
| CO3. | Analyze the multi variable optimization algorithm. |
| CO4. | Analyze the constrained optimization algorithm. |
| CO5. | Design and modelling of specialized algorithm. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Introduction

Introduction to optimization, optimal problem formulation: design variables, constraints, objective function, variable bounds, engineering optimization problems, optimization algorithms. (8L)

Module 2: Single variable optimization algorithms

Optimality criteria, bracketing methods, regional –elimination method, point estimation method, gradient based method, root finding using optimization techniques. (8L)

Module 3: Multi variable optimization algorithms

Optimality criteria, Unidirectional search, direct search method: evolutionary optimization method, Simplex search method (8L)

Module 4: Constrained Optimization algorithms

Transformation methods, sensitivity analysis, direct search for constrained minimization, linearized search technique. (8L)

Module 5: Specialized algorithms


Integer Programming: penalty function, branch and bound method, geometric programming, Bathtub curve, Genetic algorithm (GA): working principle, Differences and similarity between GAs and traditional methods, GAs for constrained optimization, real coded GAs, Advanced GAs. (8L)

Text Books

1. Kalyanmoy Deb, "Optimization for Engineering Design", First Edition, Prentice-Hall India Publishers, 2009.
2. Singiresu S. Rao, "Engineering Optimization theory and practice", Third Edition, New Age Publishers, 2018.

Reference Books

1. Jasbir Arora, "Optimal Design", Mc Graw Hill (International) Publishers.
2. D. E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", First Edition, John Wiley Publishers, 2009.
3. Kalyanmoy Deb, "Multi Objective Optimization using Evolutionary Algorithms", Wiley Student Edition.


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME603

Course title: Soft Computational Techniques in Design

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Conceptualize neural networks and its learning methods. |
| 2. | Infer the basics of genetic algorithms and their applications in optimization and planning. |
| 3. | Interpret the ideas of fuzzy sets, fuzzy logic and fuzzy inference system. |
| 4. | Categorize the tools and techniques available for soft computing, while |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Identify the soft computing techniques and their roles in building intelligent machines. |
| CO2. | Recognize an appropriate soft computing methodology for an engineering problem. |
| CO3. | Apply fuzzy logic and reasoning to handle uncertainty while solving engineering problems. |
| CO4. | Apply neural network to solve engineering problems. |
| CO5. | Apply genetic algorithms to analyze optimization problems. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Introduction: Background, uncertainty and imprecision, statistics and random processes, uncertainty in Information. Fuzzy sets and membership, chance versus ambiguity, fuzzy control from an industrial perspective, Knowledge based systems for process control, knowledge-based controllers, knowledge representation in knowledge-based controllers. (8L)

Module 2:

Mathematics of Fuzzy Control: Classical sets, Fuzzy sets, Properties of fuzzy sets, operations on fuzzy sets. Classical relations and fuzzy relations - Cartesian product, crisp relation, Fuzzy relations, Tolerance and Equivalence Relations, Fuzzy tolerance and equivalence relations, operation on fuzzy relations, The extension principle. (9L)

Module 3:

Membership Function: Features of membership functions, standard forms and boundaries, Fuzzification, Membership value assignment. Fuzzy-to-Crisp conversions: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations. De-fuzzification Methods. (8L)

Module 4:

Introduction: Structure and foundation of Single Neuron, Neural Net Architectures, Neural Learning Application, Evaluation of Networks, Implementation. Supervised Learning - Single Layer Networks, Perceptions, Linear separability, Training algorithms, Guarantee of success, Modifications. (9L)

Module 5:


Genetic Algorithms: Terminology in GA – strings, structure, parameter string, data structures, operators, coding fitness function, algorithm, applications. (6L)

Text Books

1. Fuzzy logic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.
2. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice- Hall of India Private Limited.
3. Neural Networks: A Comprehensive Foundation – SimanHaykin, IEEE, Press, MacMillan, N.Y. 1994.

Reference Books

1. Elements of Artificial Neural Networks – Kishan Mehrotra, Chilakuri K. Mohan, Sanjay Ranka (Penram International Publishing (India)


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME604
Course title: Computer Graphics
Pre-requisite(s): Computer Aided Design
Co- requisite(s): Nil
Credits: 3 **L:** 3 **T:** 0 **P:** 0
Class schedule per week: 03
Class: M. Tech.
Semester / Level: III /06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|--|
| 1. | Develop a knowledge of what is computer graphics. |
| 2. | Do future studies in Graphic primitives and attributes of primitives and to prepare the students to effectively use it in the practice of engineering. |
| 3. | Develop an intuitive understanding of why and how to incorporate computer graphics and its importance in the real world |
| 4. | Get aware of transformations and analytical & synthetic curve generation. |
| 5. | Know about viewing and clipping systems and the various applications of it in computer graphics system. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Understand the Computer Graphics and its application in real world. |
| CO2. | To know about the Graphic primitives. |
| CO3. | Able to understand the Attributes of primitives and Antialiasing. |
| CO4. | Able to understand the Transformations in computer graphics. |
| CO5. | Outline the concepts of Viewing and Clipping. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1:

Display device: Refresh Cathode ray Tubes, Random Scan and Raster Scan monitors, Colour CRT Monitors, Direct view Storage Tubes, Continuous Refresh and Storage display, LED and LCD Monitors.

Graphic primitives: Points & Lines, Line drawing Algorithm, DDA and Bresenham's Algorithm. (8L)

Module 2:

Attributes of primitives: Line style, Type, Width, Colour, Character Attributes, Area Filling, Antialiasing. Fill Algorithm: Scan-Line Polygon Fill algorithm, Boundary Fill Algorithm, Flood Fill Algorithm, Seed fill algorithm. (8L)

Module 3:

Analytical & Synthetic curve: C0, C1 & C2 Continuity, Convex hull, Parametric & non-parametric representation of curves.

Analytic curves: Circle, Ellipse, Parabola, Hyperbola, Splines: linear, quadratic, cubic, hermite, Bezier curves, Synthetic Curves: Circle and ellipse drawing, Parametric and Bresenham's algorithm. (8L)

Module 4:

2D Transformation: Basic transformation- Translation, Scaling, Rotation, Reflection, Twist, Matrix Representation, Composite Transformations.

3D Transformation: Basic Transformations, 3D Display parallel & perspective projection. (8L)


Module 5:

Viewing: Viewing world co-ordination system, Normalized co-ordinate system, Device/Image co-ordination system, Window definitions, View port definitions, Viewing transformation.

Clipping: Point clipping, Line clipping, Cohen- Sutherland clipping, Midpoint clipping method, Sutherland and Hodgman Clipping. (8L)

Text Books

1. Computer Graphics-Donald Hearn and M. Pauline Baker - Prentice Hall of India Pvt Ltd.
2. Introduction to Computer Graphics - N. Krishnamurthy - TMH Publication

 Professor & Head
Department of Mechanical Engineering
HITL Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME605

Course title: Additive Manufacturing

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 3 L: 3 T: 0 P: 0

Class schedule per week: 03

Class: M. Tech.

Semester / Level: III /06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives


This course enables the students to:

| | |
|----|---|
| 1. | Exploit technology used in additive manufacturing. |
| 2. | Understand importance of additive manufacturing in advance manufacturing process. |
| 3. | Acquire knowledge, techniques and skills to select relevant additive manufacturing process. |
| 4. | Explore the potential of additive manufacturing in different industrial sectors. |
| 5. | Apply 3D printing technology for additive manufacturing. |

Course Outcomes

After the end of the course, a student should be able to:

| | |
|------|---|
| CO1. | Define the various process used in Additive Manufacturing. |
| CO2. | Analyse and select suitable process and materials used in Additive Manufacturing. |
| CO3. | Identify, analyse and solve problems related to Additive Manufacturing. |
| CO4. | Apply knowledge of additive manufacturing for various real-life applications |
| CO5. | Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing. |


Professor & Head
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

SYLLABUS

Module 1: Introduction

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing. (8L)

Module 2: Additive Manufacturing Processes

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM). (8L)

Module 3: Additive Manufacturing Machines and Systems

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing. (8L)

Module 4: Pre-Processing in Additive Manufacturing

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials. (8L)

Module 5: Post-Processing in Additive Manufacturing

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating. (8L)

Text Books

1. Gibson, I, Rosen, D W., and Stucker,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003

COURSE INFORMATION SHEET

Course code: ME606
Course title: Optimization Techniques Lab
Pre-requisite(s): Basic programming knowledge
Co- requisite(s): Nil
Credits: 2 **L:** 0 **T:** 0 **P:** 4
Class schedule per week: 04
Class: M. Tech.
Semester / Level: III/06
Branch: Mechanical Engineering
Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Learn various optimization technique methods. |
| 2. | Understand the use of matlab in optimization problems. |
| 3. | Generate different programming in matlab for different cases. |
| 4. | Use of genetic algorithm in different optimization problems. |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Learn efficient computational procedures to solve optimization problems. |
| CO2. | Implementation of matlab in important optimization methods. |
| CO3. | Generate usable data after matlab programming for optimization problems. |
| CO4. | Produce solution for different engineering maxima/minima problems. |
| CO5. | Formulation of genetic algorithm in optimization problems. |

List of Experiments

- Experiment 1:** Introduction to optimization techniques using MATLAB
- Experiment 2:** Study of introduction of MATLAB
- Experiment 3:** Study of basic matrix operation using MATLAB
- Experiment 4:** Differentiation of a vector and matrix in Matlab
- Experiment 5:** Integration of a vector and matrix in Matlab
- Experiment 6:** Introduction to linear programming.
- Experiment 7:** Formulation of simplex algorithm in Matlab.
- Experiment 8:** Introduction to quadratic programming.
- Experiment 9:** Implementation of Newton's method in MATLAB
- Experiment 10:** Implementation of Secant method in MATLAB
- Experiment 11:** Introduction of Genetic Algorithm in optimization
- Experiment 12:** Formulation of genetic algorithm in MATLAB

 **Professor & Head**
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215

COURSE INFORMATION SHEET

Course code: ME650

Course title: Thesis Part II

Pre-requisite(s): Nil

Co- requisite(s): Nil

Credits: 16 L: T: P:

Class schedule per week:

Class: M.Tech.

Semester / Level: IV/06

Branch: Mechanical Engineering

Name of Teacher:

Course Objectives

This course enables the students to:

| | |
|----|---|
| 1. | Solve real world problems and challenges. |
| 2. | Solve the various research challenges in the field of Energy Technology. |
| 3. | Create awareness among the students of the characteristics of several domain areas where their project ideas could help humanity. |
| 4. | Improve the team building, communication and management skills of the students |

Course Outcomes

At the end of the course, a student should be able to:

| | |
|------|--|
| CO1. | Demonstrate a sound technical knowledge of their selected project topic. |
| CO2. | Undertake problem identification, formulation and solution. |
| CO3. | Design engineering solutions to complex problems utilizing a systems approach. |
| CO4. | Communicate with engineers and the community at large in written and oral forms. |
| CO5. | Demonstrate the knowledge, skills and attitudes of a professional engineer. |



Professor & Head,
Department of Mechanical Engineering
Birla Institute of Technology
MESRA, RANCHI-835215