Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL ENGINEERING

M.E. Thermal Engineering
Choice Based Credit System
(Full Time & Part Time)

2019
DEPARTMENT OF MECHANICAL ENGINEERING

VISION

The Mechanical Engineering Department endeavors to be recognized globally for outstanding education and research leading to well qualified engineers, who are innovative, entrepreneurial and successful in advanced fields of mechanical engineering to cater the ever changing industrial demands and social needs.

MISSION

The Mechanical Engineering program makes available a high quality, relevant engineering education. The Program dedicates itself to providing students with a set of skills, knowledge and attitudes that will permit its graduates to succeed and thrive as engineers and leaders. The Program strives to:

- Prepare its graduates to pursue life-long learning, serve the profession and meet intellectual, ethical and career challenges.
- Maintain a vital, state-of-the-art research enterprise to provide its students and faculty with opportunities to create, interpret, apply and disseminate knowledge.

Programme Educational Objectives (PEO)

1. To equip the students with necessary foundation for effectively analyzing and solving the problems associated in thermal engineering field.

2. To deliver comprehensive education in Thermal Engineering to ensure that the students have core competency to be successful in industry/ research laboratory and motivate them to pursue higher studies and research in interrelated areas.

3. To encourage the students to take up real life and/or research related problems and to create innovative solutions of these problems through comprehensive analysis and designing.

4. Graduates will have inculcated the ability to maintain high professionalism and ethical standards, effective technical presentation and writing skill and to work as a part of team on research projects.
Program Outcomes (PO)

PO 1: An ability to acquire, apply and share in-depth knowledge in the area of thermal engineering.

PO 2: An ability to conduct independent research and generate new knowledge for the benefit of mankind.

PO 3: Graduates will demonstrate an ability to identify, formulate and solve thermal engineering problems.

PO 4: Graduates will demonstrate research skills to critically analyze complex thermal engineering problems for synthesizing new and existing information for their solutions.

PO 5: An ability to maintain a high level of professional and intellectual integrity, ethics of research and scholarly standards.

PO 6: Graduates will demonstrate skills to use modern engineering tools, software and equipment to analyze and solve complex engineering problems.

PO 7: Graduates will demonstrate and ability to work on laboratory and multidisciplinary tasks.

PO 8: Students will be able to convey thoughts effectively on the basis of acquired soft skills and self confidence with peers, subordinates and higher authority for the consistent and effective knowledge sharing process.

PO 9: Graduates will be able to understand the need for, and an ability to engage in life-long learning and continual updating of professional skills

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# FACULTY OF ENGINEERING AND TECHNOLOGY
## DEPARTMENT OF MECHANICAL ENGINEERING
### Program : M.E
#### Specialization: Thermal Power Engineering

**CURRICULUM - 2019**

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DEPARTMENT OF MECHANICAL ENGINEERING
M.E. (Thermal Power) PART TIME - DEGREE PROGRAMME
Choice Based Credit System (CBCS)
REGULATION - 2019
Courses of Study and Scheme of Examination

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List of Program Electives
1. METPPESCN Nuclear Engineering
2. METPPESCN Energy Conservation and management
3. METPPESCN Air conditioning system design
4. METPPESCN Gas Turbines
5. METPPESCN Refrigeration and cryogenics
6. METPPESCN Design of Heat exchangers
7. METPPESCN Computational fluid dynamics
8. METPPESCN Modelling of IC engines
9. METPPESCN Solar energy and wind energy
10. METPPESCN Advanced mathematical methods in Engineering

List of Open Electives
1. METPOESCN Industrial Safety
2. METPOESCN Waste To Energy
3. METPOESCN Nuclear Engineering
4. METPOESCN Fuels And Combustion
5. METPOESCN Energy Management In Buildings
6. METPOESCN Bio Energy Conversion
7. METPOESCN Advanced Power Plant Engineering

List of Program Electives
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List of Open Electives
8. METPOESCN Industrial Safety
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11. METPOESCN Fuels And Combustion
12. METPOESCN Energy Management In Buildings
13. METPOESCN Bio Energy Conversion
14. METPOESCN Advanced Power Plant Engineering

List of Audit courses
1. METPACSCN English for Research Paper Writing
2. METPACSCN Disaster Management
3. METPACSCN Sanskrit for Technical Knowledge
4. METPACSCN Value Education
5. METPACSCN Constitution of India
6. METPACSCN Pedagogy Studies
7. METPACSCN Stress Management by Yoga
8. METPACSCN Personality Development through Life Enlightenment Skills
COURSE OBJECTIVES

- To learn the advanced concepts in Thermodynamics
- To provide knowledge of exergy, basic laws governing energy conversion
- To introduce statistical thermodynamics.
- To prepare the students to present theoretical, semi-theoretical and empirical models for the prediction of thermodynamic properties

Syllabus Contents:

First law and State postulates, Second law and Entropy, Availability and Irreversibility,

Transient flow analysis
Nonreactive Ideal-Gas Mixture, PVT Behavior of Real gases and Real Gas mixture

Generalized Thermodynamic Relationship, Combustion and Thermo-chemistry,
Second law analysis of reacting mixture, Availability, analysis of reacting mixture, Chemical equilibrium.

Statistical thermodynamics, statistical interpretations of first and second law and Entropy,

Third law of thermodynamics, Nerst heat theorem.

REFERENCES:


COURSE OUTCOMES:

At the end of the course, student will be able to:

1. Gain knowledge of exergy, basic laws governing energy conversion in multi component systems and application of chemical thermodynamics.
2. Aware of advanced concepts in thermodynamics.
3. Able to present theoretical, semi-theoretical and empirical models for the prediction of thermodynamic properties.
4. Apply fundamental principles of thermodynamics to non-ideal models of numerous engineering devices
5. Understand statistical thermodynamics
COURSE OBJECTIVES:
- To understand and define the fluid flow problems
- To solve fluid flow problems
- To explain the flow patterns and differentiate between the flow regimes and its effects

SYLLABUS CONTENTS:

**Governing equations in Fluid Dynamics:** Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities

**Exact Solutions of Navier-Stokes Equations:** Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows

**Potential Flow:** Kelvin's theorem, Irrotational flow, Stream function-vorticity approach.

**Laminar Boundary layers:** Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations

**Turbulent Flow:** Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution

**Experimental Techniques:** Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry

REFERENCES:
COURSE OUTCOMES:
At the end of the course, students will be able to
1. Understand and define the fluid flow problems along with range of governing parameters
2. Solve fluid flow problems of industrial base.
3. Devise the experiments in the field of fluid mechanics.
4. Understand the flow patterns
5. Differentiate the flow regimes and its effects.

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Course Objective:
- To formulate research problems
- To analyze the information related to results
- To introduce research ethics

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee


New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

COURSE OUTCOMES:
At the end of this course, students will be able to
1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Enhance their writing skills
5. Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity

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MEEMCP16 THERMODYNAMICS AND COMBUSTION LABORATORY

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COURSE OBJECTIVES
- To conduct the load test, speed test and Heat Balance Test of a single and double cylinder diesel engine.
- To evaluate the performance of steam boiler, turbine and condenser.
- To make the students understand the working principle of various types of governors, balancing systems, Cam analyzer, Torsional vibration of single rotor system, whirling speed concept, action of forces in gyroscope.

List of Experiments
1. Study and Performance test on Kaeser air compressor test rig.
2. Heat balance test and air fuel determination on a Diesel Engine
4. Determination of damping coefficient in damping torsional oscillation.
5. Experimentation of pressure processes station by PID control.
6. Demonstrate the gyroscopic effects and determination of gyroscopic couple.
7. Performance evaluation of loco type boiler.
COURSE OUTCOMES
Upon completing this course, students should be able to:

1. Gain knowledge about the combustion principles.
2. Analyze the performance of internal combustion engines
3. Analyze the performance of steam boiler, turbine and condenser.
4. Supplement the principles learnt in kinematics and Dynamics of Machinery.
5. Work as a team to promote lifelong learning.

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MEEMCP17 COMPUTER LABORATORY

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COURSE OBJECTIVES

- To understand the strength of OOPS using c++
- To impart programming skills in C++ programming.
- To introduce the basics of MAT LAB.

List of Experiment

- Search, generate, manipulate data using MS office/ Open Office
- Presentation and Visualization – graphs, charts, 2D, 3D
- C++, Programming.
- Simple MATLAB Exercises
- Simple CATIA Exercises

COURSE OUTCOMES
Upon completing this course, students should be able to:

1. Able to prepare slides and graphs
2. Write and compile programmes in C++
3. Develop assembly drawings with different views using auto cad
4. Solve simple mathematical models using MATLAB.
5. Write simple exercises in CATIA

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COURSE OBJECTIVES

- To develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
- To develop the numerical approach to solve the heat transfer problem
- To carry out the thermal analysis and design of heat exchangers.

Conduction

Convection

Radiation

Two phase flows and boiling and condensation heat transfer
Fundamentals of 2-phase flows: Homogenous, separated and drift flux models – Two phase flow pressure drop.

Heat Exchange Equipments

REFERENCES:
COURSE OUTCOMES
Upon On successful completion of this course the student will be able to

1. Apply the law of thermodynamics and heat transfer to real life heat transfer problems.
2. Understand the significance of heat transfer in industrial applications
3. Learn advanced topics in heat transfer
4. Learn the fundamentals of two phase flows
5. Develop numerical approach to solve problems in heat transfer

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COURSE OBJECTIVES:
- To learn the fundamentals of steam generation
- To learn steam and piping design
- To learn about energy conservation and waste minimization

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

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.

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

Boiler Performance Assessment
Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Energy Conservation and Waste Minimization
Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization

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

**REFERENCES**
1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons
6. Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answers; Tata McGrawHill Education Pvt Ltd, N Delhi

**COURSE OUTCOMES**
Upon completion of the course, students will be able to
1. Explain the working of different boilers and significance of mountings and accessories.
2. Able to use techniques, skills, and modern engineering tools necessary for boiler performance assessment
3. Able to design and develop controls and instrumentation for effective monitoring of the process
4. Enhance their ability in steam piping design
5. Understand the significance of waste minimization and energy conservation

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**COURSE OBJECTIVES**
- To make the students understand the modes of heat transfer and to conduct the trails on various experiments to analyze the heat transfer parameters.
- To understand the working of refrigeration trainer and air conditioners.
- To study the basics of solar energy.

**List of Experiments**
1. Natural convection from vertical cylinder
2. Experiments on finned tube heat exchanger
3. Experiments on unsteady state heat transfer apparatus.
4. Determination of thermal conductivity of metal rod.
5. Experiments on composite wall apparatus
6. Performance test on central A/C plant
7. Performance test on vapor absorption refrigeration system
8. Performance test on Solar still

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the behavior of a system at different operating conditions
2. Understand the various modes of heat transfer
3. Understand the working of refrigeration systems
4. Understand the usage of different refrigeration tools.
5. Learn the basics of solar energy, how to determine solar intensity, and how to estimate daily and annual solar energy potential at each location.

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COURSE OBJECTIVES:

- To train the students in the field work related to the Mechanical Engineering and to have a practical knowledge in carrying out Structural field related works.
- To train and develop skills in solving problems during execution of certain works related to Mechanical Engineering.

The students individually undergo a training program in reputed concerns in the field of Mechanical Engineering during the summer vacation (at the end of second semester for full-time / * fourth semester for part-time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training he had. Within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

* - *Four weeks during the summer vacation at the end of II Semester.*
COURSE OUTCOMES:
1. The students can face the challenges in the practice with confidence.
2. The student will be benefited by the training with managing the situation arises during the execution of works related to Mechanical Engineering.

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THIRD SEMESTER

METPPV33  PROJECT WORK & VIVA-VOCE PHASE-I  

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COURSE OBJECTIVES

- To enhance the research and development activities of the students
- To enhance the writing skills

COURSE OUTCOMES

Upon completing this course, students should be able to:
1. Understand the significance of research
2. Gain hands on experience in collection of literature
3. Improve their presentation skills
4. Enhance their thesis writing skills
5. Apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to be creative, well planned, organized, coordinated in their project work phase – II.

FOURTH SEMESTER

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COURSE OBJECTIVES

- To improve the student research and development activities.
- To improve presentation and report preparation skills.

COURSE OUTCOMES

Upon completing this course, students should be able to:
1. Understand the significance of research
2. Gain hands on experience in collection of literature
3. Improve their presentation skills
4. Enhance their thesis writing skills
5. Apply the knowledge in solving problems, so as to give confidence to be creative, well planned, organized, coordinated project outcome of the aimed work.
Mapping of COs with POs

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PROGRAM ELECTIVES

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COURSE OBJECTIVES:
- To learn the basics of nuclear engineering
- To know the reactor kinetics
- To prepare the students to exhibit a high level of professionalism, integrity, environmental and social responsibility, and life-long independent learning ability

Basics of nuclear fission and power from fission
Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding

Neutron transport and diffusion
Neutron transport equation, diffusion theory approximation, Fick’s law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down

Multigroup, multiregion diffusion equation, concept of criticality
Solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors

Reactor kinetics and control
Derivation of point kinetics equations, inhour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients

Heat removal from reactor core
Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux

Reactor safety, radiation protection
Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards

REFERENCES:
2. Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, 1966)
COURSE OUTCOMES:
At the end of the course, students will be able to
1. Understand the basic concepts and processes taking place inside a nuclear reactor.
2. Know the procedure for slowing down and absorption.
3. Familiar with concepts of reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.
4. Familiar with transient behaviour of power reactor in non-steady state operation and the means to control the reactor.
5. Familiar with concepts of heat removal from reactor core, reactor safety and radiation protection.

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COURSE OBJECTIVES:
- To understand the energy data from industries
- To carry out energy audit in machines for energy savings
- To learn the components of EB billing

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.

Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.
REFERENCES

COURSE OUTCOMES:
Upon completion of this course, the students will be able to
1. Perform energy auditing for the energy consumption in industries.
2. Know the different types of lightings
3. Understand the energy conservation measures
4. Understand the significance of energy conservation in major utilities
5. Learn the concept of energy economics

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COURSE OBJECTIVES
- To introduce the construction and design of air conditioning system
- To design seasonal energy efficient systems
- To understand the performance of air-conditioning system

Syllabus Contents:
Air conditioning systems

Various air-conditioning processes

Enthalpy deviation curve, psychrometry, SHF, dehumidified air quantity, human comfort, indoor air quality.

Design conditions and load calculations, air distribution, pressure drop, duct design, fans & blowers.

Performance & selection, noise control.
REFERENCES:
1. ASHRAE Handbook.

COURSE OUTCOMES:
At the end of the course, students should be able to
1. Understand the construction and design features of Air-conditioning system.
2. Know the various air conditioning processes
3. Understand various types and its adoptability to various environment.
4. Understand the various health issues
5. Able to design seasonal energy efficient system

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COURSE OBJECTIVES
- To introduce the components and working of gas turbines
- To learn about gas cycles
- To learn the operation of jet propulsion

Syllabus Contents:
Introduction, Cycles, Performance characteristics and improvement
Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics
Turbine construction, Blade materials, manufacturing techniques, blade fixing
Problems of high temperature operation, blade cooling, practical air cooled blades Combustion Systems, various fuels and fuel systems
Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation, environmental considerations and applications.

REFERENCES:

COURSE OUTCOMES:
At the end of the course, students will be able to
1. Understand the construction and design features of gas turbines
2. Understand the thermodynamic cycles
3. Understand the different layouts of a gas turbine plant
4. Able to understand thermodynamics and fluid mechanics component for enhancing the efficiency and effectively of gas turbines
5. Learn the operation of jet propulsion

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COURSE OBJECTIVES:
- To learn the various types of refrigeration systems and refrigerants
- To analyze the performance of refrigerator
- To learn design procedure for various components of refrigeration system

Syllabus Contents:
Vapour compression refrigeration, actual cycle, second law efficiency,
Multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems

Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor

Design, selection of evaporators, condensers, control systems, motor selection

Refrigerants, alternative refrigerants, CFC/HFC phase-out regulations,
Refrigeration applications, food preservation, transport
Introduction to Vapor absorption refrigeration, single effect and double effect systems, Gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle.

REFERENCES:

COURSE OUTCOMES:
At the end of the course, students will demonstrate the ability to:
1. Learn the basics of refrigeration and cryogenics and its application area.
2. Design the refrigeration systems for domestic and industrial applications like cold storages.
3. Learn the various refrigerants and their properties.
4. Design heat exchangers.
5. Learn about ODP, GWP and related environment issues.

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COURSE OBJECTIVES
- To design and analyze a heat exchanger.
- To introduce the effect of fouling on the performance of heat exchanger.
- To introduce different types of heat exchangers.
Syllabus Contents:
Heat Exchangers – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger.

Heat exchanger design methodology, assumption for heat transfer analysis, problem formulation, e-NTU method, P-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling.

Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop

Compact Heat Exchangers: Thermal and Hydraulic design of compact heat exchanger-Shell and Tube heat exchangers – Tinker’s, kern’s, and Bell Delaware’s methods, for thermal and hydraulic design of Shell and Tube heat exchangers

Mechanical Design of Heat Exchangers – design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

REFERENCES:
5. Afgan N. and Schlinder E.V. “Heat Exchanger Design and Theory Source Book”.

COURSE OUTCOMES:
At the end of the course, students will be able to
1. Understand the need for the design of heat exchangers
2. Demonstrate a basic understanding of several types of heat exchangers
3. Explain the working of heat pipes
5. Demonstrate the performance degradation of heat exchangers subjected to fouling.

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Mapping of COs with POs
COURSE OBJECTIVES

- To use CFD as a tool for solving heat transfer problems
- To understand the various governing equations in CFD
- To encourage students to take up further research

Syllabus Contents:

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.


Finite Volume Method: Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach

Geometry Modeling and Grid Generation: Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

Methodology of CFDHT: Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation


REFERENCES:
3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall

COURSE OUTCOMES:
At the end of the course students will be able to
1. Understand the concepts of Computational Fluid Dynamics
2. Know how to use CFD it as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems.
3. Generate various types of meshes
4. Understand the methodology of CFDHT
5. Promote interest to carry out the Future Research.

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**COURSE OBJECTIVES**

- To understand the fundamentals of IC engines modelling
- To simulate diesel, petrol engine and gas engines
- To learn the thermodynamics of engines

**Fundamentals:** Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

**Thermodynamic Combustion Models of CI Engines:** Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.

**Fuel spray behavior:** Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls.

**Modeling of charging system:** Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.

**Mathematical models of SI Engines:** Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines.

**REFERENCES:**

COURSE OUTCOMES:
At the end of the course, students will be able to
1. Demonstrate a basic understanding of several types of engine models
2. Generate different types of IC engine models
3. Simulate the spray behavior of engine.
4. Demonstrate the performance evaluation and emission standards for the modeled engines
5. Estimate friction for warm and warm up engines

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Mapping of COs with POs

COURSE OBJECTIVES:
- To understand and analyze the present and future energy demand of world and nation
- To learn the techniques to exploit the available renewable energy resources such as solar, bio-fuels, wind power, tidal and geothermal effectively
- To introduce renewable energy simulation

Solar Radiation
Availability - Measurement and Estimation - Isotropic and an Isotropic Models - Introduction to Solar Collectors (Liquid Flat - Plate Collector, Air Heater and Concentrating Collector) and Thermal Storage - Steady State and Transient Analysis - Solar Pond - Solar Refrigeration.

Modeling of Solar Thermal Systems and Simulations in Process Design

Photovoltaic Solar Cell

Wind Energy
Wind Energy Conversion System (WECS)

REFERENCES
6. hTTP://www.ises.org
7. hTTP://www.windpower-monthly.com
8. www.solarpv.com

COURSE OUTCOMES
Upon completion of the course, the students will be able to
1. Know about the exploration of non conventional energy resources and their effective tapping technologies.
2. Model solar thermal system
3. Determine the characteristics of solar thermal system
4. Understand wind turbine aerodynamics
5. Demonstrate the working of wind energy conversion system.

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COURSE OBJECTIVES:
- To impart knowledge on mathematical methods that will come in handy to solve numerical problems that arise in engineering and technology.
- To apply discrete and continuous distributions in engineering problems
- To learn the principles of design of experiments

Syllabus Contents:

Ordinary Differential Equations: First-order equations (Linear, Equidimensional, Separable Exact, Homogeneous); Second-order linear differential equations (homogeneous and nonhomogeneous); Solution methods such as undertermined coefficients and variation of parameters.

Partial Differential Equations: First order partial differential equations; Second order linear partial differential equations; Canonical forms; Fourier series, Second order equation (Parabolic, Elliptic and Hyperbolic) in rectangular, cylindrical polar and spherical coordinate systems; Solution techniques such as separation of variables, eigen function expansions, integral transforms (Fourier and Laplace transforms); D'Alembert's solution for the Wave equation; Maximum principle for Elliptic equations; Variational methods for approximate solutions of differential equations.

Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.

ANOVA: One – way, Two–way with/without interactions, Latin Squares ANOVA technique, Principles of Design of Experiments, some standard designs such as CRD, RBD, LSD.

Some of the relevant topics required for ANOVA (sample estimates and test hypothesis) may also be included.

REFERENCES:
COURSE OUTCOMES:
At the end of the course, students will demonstrate the ability to:
1. Analyze and develop mathematical model for the thermal system.
2. Analyze the reliability and maintainability of the series and parallel thermal system.
4. Perform experimental design
5. Motivate himself for a lifelong learning

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COURSE OBJECTIVES:

- To learn the significance of industrial safety
- To learn the importance of maintenance
- To learn the need for wear and corrosion prevention

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc. Safety color codes. Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.


Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.


REFERENCES:

COURSE OUTCOMES
Upon completion of the course, students will be able to
1. Know the significance of industrial safety
2. Learn the fundamentals of maintenance
3. Able to trace the fault in machines
4. Learn about wear and corrosion
5. Understand the significance of periodic maintenance

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**COURSE OBJECTIVES:**
- To learn the various resources from waste
- To introduce bio mass processing
- To study the properties of biogas

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors


Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**REFERENCES:**

**COURSE OUTCOMES**
Upon completion of the course, students will be able to
1. Understand the energy potential from waste
2. Learn the various resources from waste
3. Implement bio mass processing techniques
4. Learn the properties of biogas
5. Attempt energy generation from waste
COURSE OBJECTIVES:

- To learn the basics of nuclear engineering
- To know the reactor kinetics
- To prepare the students to exhibit a high level of professionalism, integrity, environmental and social responsibility, and life-long independent learning ability

Basics of nuclear fission and power from fission
Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding

Neutron transport and diffusion
Neutron transport equation, diffusion theory approximation, Fick’s law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down

Multigroup, multiregion diffusion equation, concept of criticality
Solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors

Reactor kinetics and control
Derivation of point kinetics equations, inhour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients

Heat removal from reactor core
Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux

Reactor safety, radiation protection
Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards

REFERENCES:
2. Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, (1966)

COURSE OUTCOMES:
At the end of the course, student will be able to
1. Understand the basic concepts and processes taking place inside a nuclear reactor
2. Know the concepts of nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.
3. Familiar with concepts of reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.
4. Familiar with time dependent (transient) behaviour of power reactor in non-steady state operation and the means to control the reactor.
5. Familiar with concepts of heat removal from reactor core, reactor safety and radiation protection.

**COURSE OBJECTIVES**

- To learn different type of conventional and non conventional fuel with their properties, methods to analysis of fuel, Energy conversion techniques in detail.
- To learn the combustion process of conventional and non conventional fuels, able to calculate the necessary air requirement for combustion process.
- To acquire knowledge in the areas of ignition, Flame study and details of burners to develop combustion process.

**Introduction**


**Solid & Liquid Fuels**


**Gaseous Fuels**


**Theory of Combustion Process and Stoichiometry**


**Burner Design**

Ignition, Concept of Ignition, Auto Ignition, Ignition Temperature, Flame, Flame Propagation, Flame Front, Various Methods of Flame Stabilization, Concepts of Burner, Basic Features and Types of Solid, Liquid and Gaseous Fuel Burners - Different Types of Coal - Oil and Gas Burners, Recuperative & Regenerative Burners.

**REFERENCES**

5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984 EIA

COURSE OUTCOMES
Upon completion of the course, students will be able to
1. Evaluate the properties of conventional and non conventional fuel, and to describe, compare, cost and availability.
2. Learn the various advantages and disadvantages of each fuel.
3. Understand the complete combustion process of each fuel.
4. Able to calculate the stoichiometry, theoretical and actual air requirement for the combustion process.
5. Understand the concepts of ignition characteristics, Flame, Flame propagation and Flame front in detail.

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COURSE OBJECTIVES
- To learn the green buildings concepts applicable to modern buildings.
- Acquaint students with the principle theories materials, construction techniques and to create energy efficient buildings.
- To learn the methodology of heat transmission in buildings

Introduction
Conventional versus Energy Efficient buildings – Historical perspective - Water – Energy – IAQ requirement analysis – Future building design aspects – Criticality of resources and needs of modern living

Landscape and Building Envelopes
Energy efficient Landscape design - Micro-climates – various methods – Shading, water bodies-
Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools.

Heat Transmission in Buildings
Surface co-efficient- air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag. Design of daylighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

Passive Cooling
Passive cooling concepts- Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth airtunnel. Hybrid methods.

Renewable Energy in Buildings
REFERENCES

COURSE OUTCOMES
Upon completion of the course, the student will be able to
1. Learn the critical resources required for a modern living
2. Perform energy audit in any type for buildings and suggest the conservation measures.
3. Implement passive cooling techniques in buildings
4. Provide the renewable energy systems for the buildings
5. Enhance their standard of living

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COURSE OBJECTIVES
- To pursue the various technologies for utilizing the bio-energy and its availability and conversion of bio-energy in the useful forms.
- Analyze elaborately the technologies available for conversion of biomass to energy in the technical update.
- Analyze the bio-energy conversion with respect to economical aspect and also in the environmental aspect.

Introduction of Biomass
Availability merits and demerits-Indian scenario-conversion mechanism-utilization of photo synthesis comparison with other energy.

Thermal Biomass Conversion
Combustion, pyrolysis, Gasification and Liquefaction-Biological Conversion-Methanol, Ethanol Production-Fermentation-Anaerobic Digestion Biodegradation and Biodegradability of Substrate.

Combustion
Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels-equivalence ratio-fixed bed and fluid Bed combustion-fuel and ash handling systems-steam cost comparison with conventional fuels.

Power Generation Techniques

Economics and Environmental Aspects
REFERENCES

COURSE OUTCOMES
Upon completion of the course, the students will be able to
1. Gain vast idea of the various form of biomass availability in the earth.
2. Get complete understanding of the various biomass energy conversion technologies,
3. Understand the importance of bio mass
4. Learn the chemistry behind the combustion process.
5. Learn the economical and environmental aspects of biomass energy conversion

COURSE OBJECTIVES
- To understand and analyze the present and future energy demand of world and nation and techniques to exploit the available renewable energy resources such as, solar, bio-fuels, wind power, tidal and geothermal effectively

Direct Energy Conversion

Power Plants

Solar Energy
Other Non-Conventional Energy Systems

Tidal Power Plants

REFERENCES

COURSE OUTCOMES
Upon the completion of the course, the students will be able to
1. Acquire fundamental knowledge in energy generation, heat transfer and to utilization
2. Gain basic knowledge in renewable energy conversion technology
3. Learn the various cycles employed in power plants
4. Ability to use modern engineering tools, software and equipment to analyze and solve complex engineering problems.
5. Solve real world problems and reduce the impact global warming for betterment of living things to serve healthy life.
COURSE OBJECTIVES
Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a title
- Ensure the good quality of paper at very first-time submission

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness


Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

REFERENCES
Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.


Disaster Prone Areas In India: Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness and Management: Preparedness: monitoring of phenomena triggering a disaster or hazard; evaluation of risk: application of remote sensing, data from meteorological and other agencies, media reports: governmental and community preparedness.


Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation in India.

REFERENCES
2. Sahni, Pardeep Et.Al. (Eds.),” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi.

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<th>METPACSCN</th>
<th>SANSKRIT FOR TECHNICAL KNOWLEDGE</th>
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COURSE OBJECTIVES
- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects
- Enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

COURSE OUTCOMES
Upon successful completion of the course, the students are able to:
1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students.

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<tr>
<th>METPACSCN</th>
<th>VALUE EDUCATION</th>
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COURSE OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character


REFERENCES

COURSE OUTCOMES
Upon successful completion of the course, the students are able to:
1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality.
COURSE OBJECTIVES
Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution: Preamble Salient Features


Organs of Governance: Parliament, Composition, Qualifications and Disqualifications Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions


REFERENCES
1. The Constitution of India, 1950 (Bare Act), Government Publication.

COURSE OUTCOMES
Upon successful completion of the course, the students are able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.


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<th>COURSE OBJECTIVES</th>
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<td>Students will be able to:</td>
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<td>- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.</td>
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<td>- Identify critical evidence gaps to guide the development.</td>
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Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions, Overview of methodology and Searching.

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers’ attitudes and beliefs and Pedagogic strategies.

Professional development: alignment with classroom practices and follow-up support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

REFERENCES
**COURSE OUTCOMES**
Upon successful completion of the course, the students are able to:
1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

**METPACSCN**

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<th>STRESS MANAGEMENT BY YOGA</th>
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**COURSE OBJECTIVES**
- To achieve overall health of body and mind
- To overcome stress

Definitions of Eight parts of yog. (Ashtanga) Yam and Niyam.
Do’s and Don’t’s in life.
(i) Ahinsa, satya, astheya, Bramhacharya and aparigraha
(ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Asan and Pranayam
(i) Various yog poses and their benefits for mind & body
(ii) Regularization of breathing techniques and its effects-Types of pranayama

**REFERENCES**
1. ‘Yogic Asanas for Group Tarining-Part-I’ : Janardan Swami Yogabhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

**COURSE OUTCOMES**
Upon successful completion of the course, the students are able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

**METPACSCN**

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<th>PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS</th>
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**COURSE OBJECTIVES**
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Neetisatakam-Holistic development of personality
- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont’s)
- Verses- 71,73,75,78 (do’s)
Approach to day to day work and duties.
Shrimad Bhagwad Geeta:
- Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35,
- Chapter 6-Verses 5,13,17,23, 35,
- Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge.
Shrimad Bhagwad Geeta:
- Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model.
Shrimad Bhagwad Geeta:
- Chapter2-Verses 17,
- Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

REFERENCES
1. “Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

COURSE OUTCOMES
Upon successful completion of the course, the students are able to:
1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.