

M.Tech Thermal Engineering 1st year (2nd semester)

Title of Course: Computational Fluid Dynamics

Course Code: TE201

L-T-P Scheme: 3-1-0

Course Credits: 4

Introduction:

Computational fluid dynamics (CFD) has become an essential tool in analysis and design of thermal and fluid flow systems in wide range of industries. Few prominent areas of applications of CFD include meteorology, transport systems (aerospace, automobile, highspeed trains), energy systems, environment, electronics, bio-medical (design of lifesupport and drug delivery systems), etc. The correct use of CFD as a design analysis or diagnostic tool requires a thorough understanding of underlying physics, mathematical modeling and numerical techniques. The user must be fully aware of the properties and limitations of the numerical techniques incorporated in CFD software. This course aims to provide precisely these insights of CFD

Course Objective:

Specific objectives may be summarized as:

1. To understand mathematical characteristics of partial differential equations.
2. To understand basic properties of computational methods – accuracy, stability, consistency
3. To learn computational solution techniques for time integration of ordinary differential equations

Course Outcomes:

After studying this course, students will be able to:

- CO1. Differentiate the FDM, FVM and FEM
- CO2. Perform the flow, structural and thermal analysis.
- CO3. Utilize the discretization methods according to the application.
- CO4. Learn computational solution techniques for various types of partial differential equations
- CO5. Learn how to computationally solve Euler and Navier-Stokes equations
- CO6. Acquire basic programming and graphic skills to conduct the flow field calculations and data analysis.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			3
CO2			2	3	3	
CO3			3		3	3
CO4			1			
CO5			3		3	
CO6	3		3			3

3 – High; 2 – Medium; 1 – Low

Course Contents:

INTRODUCTION: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations. Solution methods: Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method

FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods. Treatment of compressible flows: potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

FINITE VOLUME METHOD: Finite volume method via finite difference method, formulations for two and three-dimensional problems. STANDARD VARIATIONAL METHODS: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOKS:

1. Computational fluid dynamics T. J. Chung Cambridge University press, 2002.
2. Text book of fluid dynamics Frank Choriton CBS Publishers & distributors, 1985
3. Numerical heat transfer and fluid flow Suhas V. Patankar Hema shava Publishers corporation & Mc Graw Hill.
4. Computational Fluid Flow and Heat Transfer Muralidaran Narosa Publications
5. Computational Fluid Dynamics: Basics with applications John D. Anderson Mc Graw Hill.

Title of Course: Thermal and Nuclear Power Plant

Course Code: TE202

L-T-P Scheme: 3-1-0

Course Credits: 4

Introduction:

The nuclear power plant and the fossil thermal power plant both use steam to convert the heat or thermal energy to mechanical rotation to rotate the generator to produce electricity. Only the heat source is different. In a nuclear plant, the heat source is from the nuclear reaction whereas in a thermal power plant it is from the combustion of coal.

The difference is in the inlet steam parameters to the turbine in a nuclear plant. Thermal power plants use steam at superheated conditions. In nuclear plants, the steam is at saturated conditions and at a lower pressure. This is due to the inherent design limitations in the nuclear reactors.

Course Objectives:

To make the student understand

1. Various improvements possible in steam and gas turbines and the basics of how a nuclear reactor produces energy
2. Advanced power cycles
3. Advances in nuclear and MHD power plants
4. Environmental issues related to the power plants and nuclear fuels reload.

Course Outcomes:

The student will be able to

- CO1. Suggest improvements possible in steam and gas turbines
- CO2. Advanced power cycles and describe heat transfer and fluid flow
- CO3. Explain advances in nuclear and MHD power plants
- CO4. combined operations of different power plants and identify the major components of a nuclear power plant
- CO5. Economic analysis of power plants and handle issues related to the power plants

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3		3	
CO2			3		3	
CO3			2			3
CO4			3		3	
CO5			3			3
CO6	3		3			3

3 - High; 2 - Medium; 1 - Low

Course Contents:

INTRODUCTION: Sources of energy, Type of Power plants. Direct energy conversion system, Energy sources in India, Recent developments in power generation, Combustion of coal, Volumetric analysis, Gravimetric analysis. Fuel gas analysis.

Steam power plant: Introduction. General layout of steam power plant, Modern coal. Fired Steam, Steam power plant. Power plant cycle, Fuel Handling, Combustion equipment, Ash handling, Dust collectors. Steam Generators: Types, Accessories. Feed water heaters, Performance of boiling, Water treatment, Cooling towers. Steam turbines. Compounding of turbines, Steam condensers, Jet and surface condensers.

GAS TURBINE POWER PLANT: Cogeneration. Combined cycle power plant, Analysis, Waste heat recovery, IGCC power plant, Fluidized bed, Combustion, Advantages, Disadvantages.

NUCLEAR POWER PLANT: Nuclear physics, Nuclear Reactor, Classification, Types of reactors, Site selection. Method of enriching uranium. Application of nuclear power plant. Nuclear Power Plant Safety: Bi-Product of nuclear power generation, Economics of nuclear power plant, Nuclear power plant in India, Future of nuclear power.

ECONOMICS OF POWER GENERATION: Factors affecting the economics, Loading factors, Utilization factor, Performance and operating characteristics of power plant, Point economic load sharing, Depreciation. Energy rate, Criteria for optimum loading. Specific economic energy problem.

POWER PLANT INSTRUMENTATIONS: Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.

TEXT BOOKS:

1. Power Plant Engineering P.K.Naga TMH
2. Power Plant Engineering R.K.Rajput Lakshmi Publications.
3. Power Plant Engineering P.C.SharmaKotearia Publications.
4. Power Plant Technology Wakil.

Title of Course: Simulation, Modelling & Analysis

Course Code: TE203

L-T-P Scheme: 3-1-0

Course Credits: 4

Introduction:

The course will introduce the basic concepts of computation through modeling and simulation that are increasingly being used by architects, planners, and engineers to shorten design cycles, innovate new products, and evaluate designs and simulate the impacts of alternative approaches. Students will use MATLAB to explore a range of programming and modeling concepts while acquiring those skills. They will then undertake a final project that analyzes one of a variety of scientific problems by designing a representative model, implementing the model, completing a verification and validation process of the model, reporting on the model in oral and written form, and changing the model to reflect corrections, improvements and enhancements.

Course Objectives:

1. Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focusses what is needed to build simulation software environments, and not just building simulations using preexisting packages.
2. Introduce concepts of modeling layers of society's critical infrastructure networks.
3. Build tools to view and control simulations and their results.

Course Outcomes:

- CO1. Demonstrate basic programming skills – functions, arrays, loops, conditional statements, procedures explain the Role of Modeling: Discuss the importance of modeling to science and engineering
- CO2. Able to define the terms associated with modeling to science and engineering
- CO3. List questions that would check/validate model results

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3		3	
CO2	3					3
CO3			2		3	

3 - High; 2 - Medium; 1 - Low

Course Contents:

Introduction: Simulation: a tool, advantages and disadvantages of simulation, areas of application, systems and system environment, components of a system, discrete and continuous systems, discrete event system simulation. General Principles: Concepts in discrete event simulation, time advance algorithm, manual simulation using event scheduling, basis properties and operations.

Models In Simulation: Terminology and concepts, statistical models: queuing systems; inventory systems; reliability and maintainability, limited data, discrete distributions: Bernoulli distribution; Binomial distribution; Geometric distribution, continuous distribution: Uniform distribution; Exponential distribution; Gamma distribution; Normal distribution; Weibull distribution; Triangular Distribution; Lognormal distribution, poisson process

Queueing Models: Characteristics of queueing systems, the calling population, system capacity, arrival process, service mechanism, queueing notations, long run measures of performance of queueing systems, server utilization in $G/G/1/\infty/\infty$ queues, server utilization in $G/G/C/\infty/\infty$ queues, server utilization and system performance, costs in queueing problems, Larkovian models.

Random Number Generation: Properties of random numbers, Pseudo random numbers, techniques of generating random numbers, tests of random numbers. Random Variate Generation: Inverse transform technique, Direct transformation for the Normal and Lognormal distribution, Convolution Method, Acceptance rejection technique.

Input Modelling And Validation: Steps in the development of model, data collection, Distribution identification, Parameter estimation, Goodness of Fit Tests, selecting input models without data, verification and validation of simulation models.

TEXT BOOKS:

1. Simulation Modelling and Analysis by Law and Kelton, Mc Graw Hill.
2. Simulation Model Design & execution by Fishwick, Prentice Hall.
3. Discrete event system simulation by Banks, Carson, Nelson and Nicol.

Title of Course: Solar Energy Technology

Course Code: TE204

L-T-P Scheme: 3-1-0

Course Credits: 4

Introduction:

In this course, you will learn about the fundamentals of photoelectric conversion: charge excitation, conduction, separation, and collection. You will become familiar with commercial and emerging photovoltaic (PV) technologies and various cross-cutting themes in PV: conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, and risk analysis. Other topics covered include photovoltaic technology evolution in the context of markets, policies, society, and environment. By the year 2030, several hundred gigawatts of power must be generated from low-carbon sources to cap atmospheric CO₂ concentrations at levels deemed "lower-risk" by the current scientific consensus. The necessity to develop low-carbon energy sources represents not only an awesome technological and engineering challenge, but also an equally large economic opportunity in a trillion-dollar energy market. Students will learn how solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated, what technologies are currently on the market, and how to evaluate the risk and potential of existing and emerging solar cell technologies. We examine the potential & drawbacks of currently manufactured technologies (single- and multicrystalline silicon, CdTe, CIGS, CPV), as well as pre-commercial technologies (organics, biomimetic, organic / inorganic hybrid, and nanostructure-based solar cells). Hands-on laboratory sessions explore how a solar cell works in practice. We will learn how to enhance solar cell performance and reduce cost, and the major hurdles—technological, economic, and political—towards widespread adoption. Students will apply this knowledge towards developing a class project on the solar-related topic of their choosing.

Course Objectives:

The course is intended to

1. Introduce to the technology of renewable sources of energy
2. Evaluate different solar cell technologies and relate these to underlying theory
3. Communicate technical and socioeconomic issues of solar energy in a concise and comprehensible way by using poster presentations, Power Point or similar

Course Outcomes:

On completion of the course, the student should be able to:

- CO1. Introduce to the technology of renewable sources of energy and explain the technical and physical principles of solar cells
- CO2. Learn about the solar radiation, its applications and radiation measuring instruments
- CO3. Learn the methods of energy extraction from the sun rays.
- CO4. Learn to the technology of direct energy conversion methods

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3		3	
CO2	3					3
CO3			3		3	
CO4			2			3

3 - High; 2 - Medium; 1 - Low

Course Contents:

Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications. Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

DESIGN OF SOLAR WATER HEATING SYSTEM AND LAYOUT: Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio. THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

DIRECT ENERGY CONVERSION: solid-state principles – semiconductors – solar cells – performance – modular construction – applications. conversion efficiencies calculations.

ECONOMICS: Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

TEXT BOOKS:

1. Principles of solar engineering Kreith and Kerider Taylor and Francis 2nd edition
2. Solar energy thermal processes Duffie and Beckman John Wiley & Sons
3. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme TMH 2nd edition

Title of Course : Simulation Modeling & Analysis Lab

Course Code: TE291

L-T-P Scheme: 3-1-0

Course Credits: 4

Introduction:

Modeling and Simulation (IM/S) provides an introduction into modeling and simulation approaches, covering continuum methods (e.g. finite element analysis), atomistic simulation (e.g. molecular dynamics) as well as quantum mechanics. Atomistic and molecular simulation methods are new tools that allow one to predict functional material properties such as Young's modulus, strength, thermal properties, color, and others directly from the chemical makeup of the material by solving Schroedinger's equation (quantum mechanics). This approach is an exciting new paradigm that allows to design materials and structures from the bottom up — to make materials greener, lighter, stronger, more energy efficient, less expensive; and to produce them from abundant building blocks. These tools play an increasingly important role in modern engineering! In this subject you will get hands-on training in both the fundamentals and applications of these exciting new methods to key engineering problems.

Objective:

- Introduce computer simulation technologies and techniques, provides the foundations for the student to understand computer simulation needs, and to implement and test a variety of simulation and data analysis libraries and programs. This course focusses what is needed to build simulation software environments, and not just building simulations using pre existing packages.
- Introduce concepts of modeling layers of society's critical infrastructure networks.

Course Outcomes:

Upon completion of this course,

- CO1.** The Students can demonstrate different measurement technologies and use of them in Industrial Components
- CO2:** Build tools to view and control simulations and their results.
- CO3:** Introduce concepts of modeling layers of society's critical infrastructure networks.

Mapping of Course Outcomes and Programme Outcomes

Mapping	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3			3
CO2	3	3	3			
CO3	3	2	3			

3 - High; 2 - Medium; 1 - Low

Course Contents:

1. Study of simulation software Like ARENA , MATLAB.
2. Simulation of translational and rotational mechanical systems
3. Simulation of Queuing systems
4. Simulation of Manufacturing System
5. Generation of Random number
6. Modeling and Analysis of Dynamic Systems
7. Simulation mass spring damper system
8. Simulation of hydraulic and pneumatic systems.
9. Simulation of Job shop with material handling and Flexible manufacturing systems
10. Simulation of Service Operations