# ACADEMIC REGULATIONS
# PROGRAM STRUCTURE
# and
# DETAILED SYLLABUS

## Master of Technology
## ( Thermal Engineering )

(Two Year Regular Programme)
(Applicable for the Batches admitted from 2014)

**GOKARAJU RANGARAJU**
**INSTITUTE OF ENGINEERING AND TECHNOLOGY**
(Autonomous)

# Gokaraju Rangaraju
# Institute of Engineering and Technology, Hyderabad
# M. Tech. GR14 Regulations

Gokaraju Rangaraju Institute of Engineering & Technology 2014 Regulations (GR14 Regulations) are given hereunder. These regulations govern the programmes offered by the Department of Mechanical Engineering with effect from the students admitted to the programmes in 2014-15 academic year.

1. **Programme Offered:** The programme offered by the Department is M.Tech in Thermal Engineering, a two-year regular programme.

2. **Medium of Instruction:** The medium of instruction (including examinations and reports) is English.

3. **Admissions:** Admission to the M.Tech in Thermal Engineering Programme shall be made subject to the eligibility, qualifications and specialization prescribed by the Institute/University from time to time. Admissions shall be made either on the basis of the merit rank obtained by the student in PGECET conducted by the APSCHE for M. Tech Programmes or on the basis of any other order of merit approved by the University, subject to reservations as prescribed by the Government from time to time.

4. **Programme Pattern**
   a) Each Academic year of study is divided into two semesters.
   b) Minimum number of instruction days in each semester is 90.
   c) The total credits for the Programme is 88.
   d) All the registered credits will be considered for the calculation of the final percentage of marks.

5. **Award of M.Tech Degree:** A student will be declared eligible for the award of the M. Tech Degree if he/she fulfills the following academic requirements:
   a) A student shall be declared eligible for the award of M.Tech degree, if he/she pursues the course of study and completes it successfully in not less than two academic years and not more than four academic years.
   b) A Student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the date of admission, shall forfeit his/her seat in M.Tech course.
   c) The Degree of M.Tech in Thermal Engineering shall be conferred by Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, on the students who are admitted to the programme and fulfill all the requirements for the award of the degree.

**6. Attendance Requirements**

a) A student shall be eligible to appear for the end semester examinations if he/she puts in a minimum of 75% of attendance in aggregate in all the courses concerned in the semester.

b) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in a semester may be granted. A committee headed by Dean (Academic Affairs) shall be the deciding authority for granting the condonation.

c) Students who have been granted condonation shall pay a fee as decided by the Academic Council.

d) A candidate shall get minimum required attendance at least in three (3) theory subjects in the semester to get promoted to the next semester. In order to qualify for the award of M.Tech Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

e) Students whose shortage of attendance is not condoned in any semester are detained and are not eligible to take their end examinations of that semester. They may seek re-registration for that semester when offered next with the academic regulations of the batch into which he/she gets re-registered.

**7. Paper Setting, Evaluation of Answer Scripts, Marks and Assessment**

a) Paper setting and Evaluation of the Answer Scripts shall be done as per the procedures laid down by the Academic Council of the College from time to time.

b) The following is the division of marks between internal and external evaluations.

| Particulars | Internal | External | Total |
|---|---|---|---|
| Theory | 40 | 60 | 100 |
| Practical | 40 | 60 | 100 |
| Comprehensive Viva | -- | 100 | 100 |
| Seminar | 50 | ---- | 50 |
| Project Work | Grade | ----- | ---- |
| Project work & dissertation (Grading System) | ------ | Grade | ---- |

c) Continuous Internal Evaluation and Semester End Examinations

The assessment of the student's performance in each course will be based on continuous internal evaluation and semester-end examinations. The marks for each of the component of assessment are fixed as shown in the following Table.

**Assessment Procedure**

| S.No | Component of Assessment | Marks Allotted | Type of Assessment | Scheme of Examinations |
|---|---|---|---|---|
| 1 | Theory | 40 | Internal Exams & Continuous Evaluation | 1. Mid-examinations: … 30 Marks (Two mid-semester examinations shall be conducted for 30 marks each for duration of 2 hours. Average of the two mid semester examinations shall be considered)<br>2. Tutorial: … … 5 Marks<br>3. Attendance: .. 5 Marks |
| | | 60 | Semester-end examination | The semester-end examination is for a duration of 3 hours |
| 2 | Practical | 40 | Internal Exams & Continuous Evaluation | 1) Lab Internal :15 marks<br>2) Record : 5 marks<br>3) Continuous Assessment : 15 marks<br>4) Attendance : 5 marks |
| | | 60 | Semester-end examination | The semester-end examination is for a duration of 3 hours. |

d) Comprehensive Viva: There shall be a Comprehensive Viva-Voce in II year I semester. The Comprehensive Viva-Voce will be conducted by the committee consisting of Head of the Department and two senior faculty members of the Department. The Comprehensive Viva-Voce is aimed to assess the student's understanding in various subjects he/she studies during the M.Tech course of study. The Comprehensive Viva-Voce is valued for 100 marks by the committee. There are no internal marks for the Comprehensive Viva-voce.

e) Seminar: There shall be three Seminar Presentations by the student, one each in the I,II and III semesters. For the seminar, the student shall collect the information on a specialized topic other than his/her project and prepare a technical report, showing his understanding over the topic, and submit to the department, which shall be evaluated by a Departmental committee consisting of the Head of the department, seminar Supervisor and a senior faculty member. The seminar report shall be evaluated for 50 marks. There shall be no external examination for seminar.

f) Project: The work on the project shall be initiated in the beginning of the second year and the duration of the project is for two semesters (III & IV). Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the Project Review Committee (PRC).

i) PRC shall be constituted with HOD as chair person, two senior faculty members and project supervisor.

ii) Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

iii) A candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the PRC for its approval. Only after obtaining the approval of PRC the student can initiate the Project work.

iv) If a candidate wishes to change his supervisor or topic of the project he/she can do so with approval of PRC. However, the PRC shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, his date of registration for the project work starts from the date of change of supervisor or topic as the case may be.

v) Project Work: The candidate should be continuously observed by the project supervisor. His performance is assessed by the PRC through a seminar and interim report. Full credits are awarded 'SAT' on satisfactory performance of the student. 'US' grade is given on unsatisfactory performance. If the performance is unsatisfactory, the PRC should redefined the project and the candidate is allowed to appear for the evaluation only after six months.

vi) Project Work & Dissertation: A candidate shall submit status report (in a bound-form) in two stages at least with a gap of 3 months between them to the project supervisor.

vii) A candidate is permitted to submit Project dissertation only after successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of dissertation to the Head of the Department and shall make an oral presentation before the PRC along with project supervisor.

viii) Student has to submit to the department three copies of the Project dissertation along with a soft copy on CD certified by the supervisor.

ix) The dissertation shall be adjudicated by one examiner selected by the Controller of examination from the panel of 3 examiners as suggested by Head of the Department, who are eminent in that field with the help of the concerned guide and head of the department.

x) If the report of the Examiner is not favorable, the candidate shall revise and resubmit the dissertation, in the time frame as described by PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected.

xi) If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the Department and the examiner who adjudicated the dissertation. The Board shall jointly report candidates work as:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory.

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination.

If the report of the viva-voce is unsatisfactory, the candidate will retake the viva-voce examination after three months. If he/she fails to get a satisfactory report at the second viva-voce examination, he/she will not be eligible for the award of the degree.

8. **Recounting of Marks in the End Examination Answer Books:** A student can request for re-counting of his/her answer book on payment of a prescribed fee.

9. **Re-evaluation of the End Examination Answer Books:** A student can request for re-evaluation of his/her answer book on payment of a prescribed fee.

10. **Supplementary Examinations:** A student who has failed in an end semester examination can appear for a supplementary examination, as per the schedule announced by the College/Institute.

11. **Malpractices in Examinations:** Disciplinary action shall be taken in case of malpractices during Mid/ End-examinations as per the rules framed by the Academic Council.

12. **Academic Requirements:**

a) A student shall be deemed to have secured the minimum academic requirements in a subject if he / she secures a minimum of 40% of marks in the Semester-end Examination and a minimum aggregate of 50% of the total marks in the Semester-end examination and Internal Evaluation taken together.

b) In order to qualify for the award of M.Tech Degree, the student shall complete the academic requirements of passing in all the Courses as pe the course structure including Seminars and Project if any.

c) In case a Student does not secure the minimum academic requirements in any course, he/she has to reappear for the Semester-end Examination in the course, or re-register for the same course when next offered or re-register for any other specified course, as may be required. However, one more additional chance may be provided for each student, for improving the internal marks provided the internal marks secured by a student are less than 50% and he/she failed finally in the course concerned. In the event of taking another chance for re-registration, both the internal and external marks obtained in the previous attempt are nullified. In case of re-registration, the student has to pay the re-registration fee for each course, when next offered.

13. **Award of Class:** After a student satisfies all the requirements prescribed for the completion of the Degree and becomes eligible for the award of M. Tech Degree by JNTUH, he/she shall be placed in one of the following three classes:

| Class Awarded | % of Marks Secured |
|---|---|
| First Class with Distinction | Marks ≥ 70% |
| First Class | 60% ≤ Marks < 70% |
| Second Class | 50% ≤ Marks < 60% |

14. **Withholding of Results:** If the student has not paid dues to the Institute/ University, or if any case of indiscipline is pending against him, the result of the student (for that Semester) may be withheld and he/she will not be allowed to go into the next Semester. The award or issue of the Degree may also be withheld in such cases.

15. **Transfer of students from the Constituent Colleges of JNTUH or from other Colleges/ Universities:** Transfer of students from the Constituent Colleges of JNTUH or from other Colleges/ Universities shall be considered only on case-to-case basis by the Academic Council of the Institute.

16. **Transitory Regulations:** Students who have discontinued or have been detained for want of attendance, or who have failed after having undergone the Degree Programme, may be considered eligible for re-registration to the same or equivalent subjects as and when they are offered.

## 17. General Rules

a) The academic regulations should be read as a whole for the purpose of any interpretation.

b) In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Academic Council is final.

c) In case of any error in the above rules and regulations, the decision of the Academic Council is final.

d) The college may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the Institute/ University.

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## M.TECH (Thermal Engineering)

### TE - M.Tech - I Year, I Semester

| Group | Sub-Code | Subject | Credits | Int | Ext | Marks |
|---|---|---|---|---|---|---|
| PC | GR14D5131 | Advanced Thermodynamics | 3 | 40 | 60 | 100 |
| PC | GR14D5132 | Conduction And Radiation Heat Transfer | 3 | 40 | 60 | 100 |
| PC | GR14D5133 | Advanced Fluid Mechanics | 3 | 40 | 60 | 100 |
| PC | GR14D5134 | Advanced Finite Element analysis | 3 | 40 | 60 | 100 |
| | | **Elective I** | 3 | 40 | 60 | 100 |
| PE | GR14D5135 | Turbo machines | | | | |
| | GR14D5136 | Optimization techniques | | | | |
| | GR14D5137 | Theory of Heat Pipes | | | | |
| | | **Elective II** | 3 | 40 | 60 | 100 |
| PE | GR14D5138 | Refrigeration & Air- Conditioning | | | | |
| | GR14D5139 | Jet Propulsion And Rocketry | | | | |
| | GR14D5140 | Thermal And Nuclear Power Plants | | | | |
| LAB | GR14D5141 | Thermal Engineering Lab | 2 | 40 | 60 | 100 |
| SPW | GR14D5175 | Seminar-I | 2 | — | — | — |
| | | **Total** | **22** | **280** | **420** | **700** |

### TE - M.Tech- I Year, II Semester

| Group | Sub-Code | Subject | Credits | Int | Ext | Marks |
|---|---|---|---|---|---|---|
| PC | GR14D5142 | Convective Heat Transfer | 3 | 40 | 60 | 100 |
| PC | GR14D5143 | Computational Methods In Heat Transfer | 3 | 40 | 60 | 100 |
| PC | GR14D5144 | Advanced IC Engines | 3 | 40 | 60 | 100 |
| PC | GR14D5145 | Equipment Design For Thermal Systems | 3 | 40 | 60 | 100 |
| | | **Elective III** | 3 | 40 | 60 | 100 |
| PE | GR14D5146 | Thermal Measurements And Process Controls | | | | |
| | GR14D5147 | Alternate Energy Sources | | | | |
| | GR14D5148 | Cryogenics Engineering | | | | |
| | | **Elective IV** | 3 | 40 | 60 | 100 |
| PE | GR14D5149 | Fuels, Combustion and Environment | | | | |
| | GR14D5150 | Multiphase Flow | | | | |
| | GR14D5151 | Solar Energy Technology | | | | |
| LAB | GR14D5152 | Computational Methods Laboratory | 2 | 40 | 60 | 100 |
| SPW | GR14D5176 | Seminar-II | 2 | — | — | — |
| | | **Total** | **22** | **280** | **420** | **700** |

## TE - M.Tech - II Year, I Semester

| Group | Sub-Code | Subject | Credits | Int | Ext | Marks |
|---|---|---|---|---|---|---|
| SPW | GR14D5178 | Comprehensive Viva | 2 | — | 100 | 100 |
| SPW | GR14D5177 | Seminar-III | 2 | 50 | — | 50 |
| SPW | GR14D5179 | Project work | 18 | Grade | | |
| | | **Total** | **22** | **50** | **100** | **150** |

## TE - M.Tech - II Year, II Semester

| Group | Sub-Code | Subject | Credits | Int | Ext | Marks |
|---|---|---|---|---|---|---|
| SPW | GR14D5180 | Project work and Dissertation | 22 | Grade | | |

# I-Year

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## ADVANCED THERMODYNAMICS

Course Code: GR14A5131 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Engineering Mathematics
- Engineering Thermodynamics

**Course Objectives**
- Develop an ability to identify, formulate, and solve engineering problems
- explain basic thermodynamic concepts and laws
- Describe the concepts entropy and energy and their use in analyses of thermal energy systems
- analyze power plants, refrigeration plants and thermal/chemical installations
- Master the methods for analyzing multi-component systems
- Master the property equations and thermodynamic properties of real gases

**Course Outcomes**
Upon completion of this course, students will be able to:
- Apply engineering principles and analyze problems dealing with advanced thermodynamics.
- Grasp the thermodynamic properties and basic concepts of phase equilibrium of multi component systems.
- Determine the direction of the process from the first and second law of thermodynamics.
- Understand the availability, energy, and energy equilibrium equations.
- Be familiar with property equations and thermodynamic properties of real gases.

**Unit-I**
**Review of Thermodynamic Laws and Corollaries:** Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance

**Unit-II**
**P.V.T Surface:** Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour

pressure, Clausius, Clapeyron equation. Throttling, Joule. Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

**Unit-III**

**Combustion:** Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gases, Effect of non reacting gases equilibrium in multiple reactions, The vent Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

**Unit-IV**

**Power Cycles:** Review binary vapour cycle, co generation and combined cycles, Second law analysis of cycles. Refrigeration cycles. Thermodynamics off irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermoelectric circuits.

**Unit-V**

**Direct Energy Conversion Introduction:** Fuel cells, Thermo electric energy, Thermionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH
2. Thermodynamics/Holman/ Me Graw Hill.
3. Engg. Thermodynamics/PL.Dhar / Elsevier

**Reference Books**

1. Thermodynamics/Sonnatag & Van Wylen / John Wiley & Sons
2. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons
3. Irreversible thermodynamics/HR De Groff.
4. Thermal Engineering / Soman / PHI
5. Thermal Engineering / Rathore / TMH
6. Engineering Thermodynamics/Chatopadyaya/

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## CONDUCTION AND RADIATION HEAT TRANSFER

Course Code: GR14A5132 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Basic Thermodynamics
- Concepts Of Differential And Integral Calculus

**Course Objectives**
- To make students familiar with fundamental heat transfer concepts: conservation of energy, mechanisms of energy conversion, and mechanisms of heat transfer (conduction, radiation )
- To teach balance of energy applied to integral- and differential-volumes and discuss finite-small volume applied in numerical analysis
- To teach the physics of thermal conduction in fluids and in solids (metals, plastics, ceramics) and composites such as insulation and define thermal conduction resistance
- To teach the physics of thermal radiation and thermal surface properties, and define surface-grayness and view-factor resistance

**Course Outcomes**
- Formulate engineering and natural thermal systems in terms of conservation of energy
- Relate the rate of heat transfer to the potential for heat flow (difference in temperature) and thermal resistances
- Determine these resistances for conduction, radiation heat transfer, using the fundamental relationships and correlations

**UNIT-I**

**Brief Introduction to Different Modes of Heat Transfer Conduction:** General heat conduction equation-in cartesian, cylindrical and spherical coordinate systems Initial and Boundary conditions One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres – overall heat transfer coefficient – electrical analogy– Critical radius of insulation.
One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation.

**Unit-II**

**Heat Conduction**: Methods of formulation – integral, and differential formulations; initial and boundary conditions, different kinds of boundary conditions, homogeneous boundary conditions; transient response of thermocouples in the measurement of fluctuating gas temperature; integral formulation of heat conduction in a pin fin of uniform cross section and its approximate analytical solution – heat transfer characteristics of straight, annular, and pin fins of uniform and non-uniform cross sections.

**Unit -III**

**Transient Heat Conduction:** Differential formulation of transient heat conduction problems with time- independent boundary conditions in rectangular, cylindrical, and spherical geometries and their analytical solution - method of separation of variables, method of Laplace transforms; differential formulation of steady two-dimensional heat conduction problems in rectangular, cylindrical, and spherical geometries and their analytical solution - methods of separation of variables; treatment of non-homogeneity in differential equations and boundary conditions – method of superposition.

**Unit- IV**

**Radiation Heat Transfer:** Review of basic definitions – black, gray, opaque, transparent, and translucent bodies, transmissivity of a body, diffuse and specular surfaces; emissivity, absorptivity, and reflectivity of real surfaces; solid angle; radiation intensity, emissive power; irradiation, radiosity; radiant energy exchange between two differential area element; radiation shape factor, radiation shape factor between a differential element and a finite area and between two finite areas, crossed-string method, properties of shape factor – reciprocal, additive, and enclosure properties, shape factor algebra.

**Unit-V**

Radiant energy exchange between two surfaces, reradiating surfaces, radiation shields; Radiant energy exchange in enclosures – enclosure composed of black surfaces, enclosure composed of diffuse-gray surfaces; electrical network analogy; radiant energy exchange in presence of absorbing and transmitting media, radiant energy exchange in presence of transmitting, reflecting and absorbing media; radiant energy exchange in the presence of conduction and convection.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Heat Transfer – Necati Ozisik (TMH)
2. Heat and Mass Transfer – O P Single (Macmillan India Ltd)
3. Heat Transfer – P.S. Ghoshdastidar (Oxford Press)
4. Engg. Heat & Mass Transfer- Sarit K. Das (Dhanpat Rai)

**Reference Books**


1. Fundamentals of Heat & Mass Transfer – Incroera Dewitt (Jhon Wiley)
2. Heat Transfer : A basic approach – Yunus Cangel (MH)
3. Heat & Mass Transfer – D.S. Kumar
4. Heat Transfer – P.K. Nag(TMH)
5. Principle of Heat Transfer – Frank Kreith & Mark.Bohn.
6. Convective Heat and Mass Transfer / W.M.Kays & M.E.Crawford(TMH)
7. Radiation Heat Transfer –G.M.Sparrow& R.D.Cess
8. Thermal Radiation heat transfer – R.Siegel & J.R.Howell
9. Radiation Heat Transfer – H.G.Hottel & A.F.Sarofim

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## ADVANCED FLUID MECHANICS

Course Code: GR14A5133 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Basic Thermodynamics
- Concepts Of Differential And Integral Calculus

**Course Objectives**
- Learn to use control volume analysis to develop basic equations and to solve problems.
- Understand and use differential equations to determine pressure and velocity variations in internal and external flows.
- Understand the concept of viscosity and where viscosity is important in real flows.
- Learn to use equations in combination with experimental data to determine losses in flow systems. Learn to use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity.

**Course Outcomes**
At the end of the course the learners will be able to
- Apply knowledge of mathematics, science and engineering.
- Derive the governing equations of fluid flow and applying them to simple flow problems.
- Emphasizing the mathematical formulation of various flow problems.
- Apply the boundary layer concept to the fluid flow problems.

**Unit-I**
**Non – viscous flow of incompressible Fluids:** Lagrangian and Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions.
Basic Laws of fluid Flow: Condition for irrotationality, circulation & vorticity Accelerations in Cartesian systems normal and tangential accelerations, Euler's, Bernoulli equations in 3D– Continuity and Momentum Equations.

**Unit-II**
**Principles of Viscous Flow:** Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases : Plain Poisoulle flow - Coutte flow with and without pressure gradient - Hagen Poisoulle flow - Blasius solution.

**Unit-III**

Boundary Layer Concepts Prandtl's contribution to real fluid flows-Prandtl's boundary layer theory-Boundary layer thickness for flow over a flat plate-Approximate solutions-Creeping motion (Stokes)-Oseen's approximation-Von-Karman momentum integral equation for laminar boundary layer-Expressions for local and mean drag coefficients for different velocity profiles.

**Unit-IV**

**Introduction to Turbulent Flow:** Fundamental concept of turbulence-Time Averaged Equations – Boundary Layer Equations - Prandtl Mixing Length Model-Universal Velocity Distribution Law: Van Driest Model -Approximate solutions for drag coefficients – More Refined Turbulence Models-k-epsilon model - boundary layer separation and form drag-Karman Vortex Trail, Boundary layer control, lift on circular cylinders Internal Flow: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth rough Pipes- Roughness of Commercial Pipes-Moody's diagram.

**Unit-V**

**Compressible Fluid Flow-I**: Thermodynamic basics-Equations of continuity, Momentum and Energy-Acoustic Velocity Derivation of Equation for Mach Number-Flow Regimes-Mach Angle -Mach Cone-Stagnation State.

**Compressible Fluid Flow-II:** Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers-Fanno and Releigh Lines, Property Relations-Isothermal Flow in Long Ducts-Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks-Supersonic Wave Drag.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Schlichting H – Boundary Layer Theory (Springer Publications).
2. Convective Heat and Mass Transfer – Oosthigen, McGrawhill
3. Convective Heat and Mass Transfer – W.M. Kays, M.E. Crawford, McGrawhill

**Reference Books**

1. Yuman S.W – Foundations of Fluid Mechanics.
2. An Introduction to Compressible Flow – Pai.
3. Dynamics & Theory and Dynamics of Compressible Fluid Flow – Shapiro.
4. Fluid Mechanics and Machinery – D. Rama Durgaiah.(New Age Pub.)
5. Fluid Dynamics – William F. Hughes & John A. Brighton (Tata McGraw-Hill Pub.)

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## ADVANCED FINITE ELEMENT ANALYSIS

Course Code: GR14A5134 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Numerical Methods
- Concepts Of Strength Of Materials

**Course Objectives:** The course is intended to
- Gain a fundamental understanding of the finite element method for solving boundary value problems .
- Learn important concepts of variational form, minimum potential energy principles, and method of weighted residuals.
- Study one dimensional problems such as truss, beam, and frame members, two-dimensional problems such as plain stress and plain strain elasticity problems, torsion problem.
- Learn finite element analysis of static and dynamic problems and heat transfer problems.
- provide the student with some knowledge and analysis skills in applying basic laws in mechanics and integration by parts to develop element equations and steps used in solving the problem by finite element method.

**Course Outcomes:** At the end of the course the learners will be able to
- Apply the concepts of minimum potential energy principles to solve structural mechanics problems. Compute Eigen values and eigenvectors of simple dynamic systems
- Obtain weak form from strong form and total potential, and recognize similarities between such solutions, and those obtained by variational principles and principal of virtual work.
- Obtain finite element solution and compare with exact solution of simple one dimensional problems.
- Apply the finite element procedure for stress analysis and design of load carrying structures and heat transfer problems

**Unit-I**

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Galerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

**Unit-II**

**1-D Structural Problems:** Axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape functions and problems.

ANALYSIS OF TRUSSES : Plane Trusses and Space Truss elements and problems

ANALYSIS OF BEAMS : Hermite shape functions – stiffness matrix – Load vector – Problems.

**Unit-III**

**2-D Problems:** CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.

3-D PROBLEMS: Tetrahedran element – Jacobian matrix – Stiffness matrix.

**Unit-VI**

**Scalar Field Problems:** 1-D Heat conduction-Slabs – fins - 2-D heat conduction problems –Introduction to Torsional problems.

**Unit-V**

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector,natural frequencies – mode shapes – modal analysis.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Finite Element Methods: Basic Concepts and applications, Alavala, PHI
3. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice –Hall

**Reference Books**

1. Finite Element Method – Zincowitz / Mc Graw Hill
2. Introduction to Fininte element analysis- S.Md.Jalaludeen,Anuradha Publications, print-2012
3. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition
4. Finite Element Method – Krishna Murthy / TMH
5. Finite Element Analysis – Bathe / PHI

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE I
## TURBO MACHINES

Course Code: GR14A5135 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Compressors And Turbines

**Course Objectives:** The course is intended to
- Understand the fundamental concepts of turbo machines.
- Apply concepts of fluid mechanics in turbo machines.
- Understand the thermodynamic analysis of steam nozzles and turbines.
- Understand the different types of compressors and evaluating their performances in the form of velocity triangles.
- Familiarize the basic concepts of gas dynamics and analyze the performance of axial flow gas turbines.

**Course Outcomes:** At the end of the course the learners will be able to
- Able to derive the basic equations used for turbo machines.
- Will be able to understand the concept of velocity triangles used for performance evaluation of turbines.
- Able to understand the concept of degree of reaction for axial flow compressors.

**Unit-I**

**Fundamentals of Turbo Machines:** Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines

**Unit-II**

**Steam Nozzles:** Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of backpressure of analysis. Designs of nozzles.

**Steam Turbines:** Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

**Unit-III**

**Gas Dynamics:** Fundamental thermodynamic concepts, isentropic conditions, mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Super sonic flow, oblique shock waves. Normal shock recoveries, Detached shocks, Aerofoil theory.

**Centrifugal Compressor:** Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formulas, Effect of inlet mach numbers, Pre whirl, Performance

**Unit-IV**

**Axial Flow Compressors:** Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Drgree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance

**Cascade Analysis:** Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

**Unit-V**

**Axial Flow Gas Turbines:** Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons
3. Element of Gas Dynamics/Yahya/TMH

**Reference Books**

1. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/Newyork
2. Turbines, Pumps, Compressors/Yahya/TMH
3. Practice on Turbo Machines/ G.Gopal Krishnan & D.Prithviraj/ Sci Tech Publishers, Chennai
4. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
5. Gas Turbines Theory and Practice/Zucrow/John Wiley & Sons/Newyork
6. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE I
## OPTIMIZATION TECHNIQUE

Course Code: GR14A5136 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Operations Research
- Concepts of Mathematics

**Course Objectives:** The course is intended to
- Develop systematic approach to handle problems to design of electrical circuit etc; with a goal of maximizing the profit and minimizing cost.
- Understand the various optimization techniques such as classified optimization, linear programming. One dimensional minimization methods, unconstrained optimization techniques, constrained optimization techniques and dynamic programming.
- Understand the necessary sufficient conditions for finding the solution of the problems in classical optimization.
- Comprehend the numerical methods for finding approximate solution of complicated problems.

**Course Outcomes:** At the end of the course the learners will be able to
- Design of mechanical systems and interdisciplinary engineering applications and business solutions using suitable optimization technique.
- Apply numerical or iterative techniques in power systems for optimal power flow solutions.
- Optimize the parameters in control systems for desired steady state or transient response.
- Optimize the cost function in deciding economic factors of power systems.

**Unit-I**
**Single Variable Non-linear Unconstrained Optimization:** One dimensional Optimization methods:- Uni-modal function, elimination methods, ,, Fibonacci method, golden section method, interpolation methods – quadratic & cubic interpolation methods. Multi variable non-linear unconstrained optimization: Direct search method – Univariant method - pattern search methods – Powell's-Hook Jeeves, Rosenbrock search methods- gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

**Unit-II**

**Geometric Programming:** Polynomials – arithmetic - geometric inequality – unconstrained G.P- constrained G.P

**Unit-III**

**Dynamic Programming:** Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory, allocation, scheduling replacement.

**Unit-IV**

**LINEAR PROGRAMMING:** Formulation – Sensivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Simulation – Introduction – Types- steps – application – inventory – queuing – thermal system.

**Unit-V**

**Integer Programming**

Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

**Stochastic Programming:** Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution- stochastic linear, dynamic programming.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Optimization theory & Applications / S.S.Rao / New Age International.
2. Introductory to operation Research / Kasan & Kumar / Springar
3. Optimization Techniques theory and practice / M.C.Joshi, K.M.Moudgalya/ Narosa Publications

**Reference Books**

1. S.D.Sharma / Operations Research
2. Operation Research / H.A.Taha /TMH
3. Optimization in operations research / R.LRardin
4. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE I
## THEORY OF HEAT PIPES

Course Code: GR14A5137 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Heat Transfer
- Concepts of Phase Change Heat Transfer

**Course Objectives:** The course is intended to
- To understand the heat pipes principles ,working fluids and wick structures
- To know about the heat pipe limitations like capillary, sonic entrainment and boiling limitations.
- To understand the principles of design and manufacture of heat pipes.

**Course Outcomes:** At the end of the course the learners will be able to
- Select a suitable heat pipe for a particular heating and cooling applications.
- Calculate the maximum and minimum heat capacities of a particular heat pipe .

**Unit-I**
Operating principle, Working fluids and its temperature ranges, heat transfer limits and heat pipe characteristics , various applications Interfacial heat and transfer , physical surface phenomena , capillary and disjoining forces – Interfacial resistance in vaporization and condensation process , Interfacial mass , momentum energy , pressure balance – interfacial phenomena in grooved structures

**Unit-II**
Steady Hydrodynamics – thermal characteristics and heat transfer limitation , thermal fluid phenomena in capillary media , vapor flow analysis , thermal characteristics including the wall effects and effect of vapor flow – capillary boiling – sonic , entrainment , viscous , condenser , continuum and frozen startup limitations

**Unit-III**
Area temperature relations , Pipe dimensions and structural considerations. Heat pipe heat exchanger, transient model calculations and procedures

**Unit-IV**

Heat Pipe Behavior- Transient response to sudden change in temperature heat input , frozen startup and shut down of heat pipe – numerical and analytical model for frozen startup.

**Unit-V**

Two phase closed thermo siphon reflux-condensation heat transfer in analysis, evaporation heat transfer analysis, transient and oscillatory behavior of thermo siphon, Minimum liquid fill requirement, Thermo syphon with capillary wicks

**Teaching methodologies**

1. Power Point Presentations
2. Tutorials
3. Working Model Fabrication

**Text Books**

1. S.W.Chi,1976 , Heat pipe theory and practice, Hemisphere publishing corporation , Washington
2. Dunn, P.D.and Reay D.A. 1982 , “Heat Pipes” , Third Edition , Pregamon Press
3. Amir Faghri , 1995 Heat Pipe science and Technology , publisher , Taylor and Francis
4. V.P. Carey , 1992 , Liquid-Vapor phase-Change phenomena. An Introduction to the Thermophysics of vaporization and condensation processes in heat transfer equipment , Hemisphere Publishers , New York
5. J.N.Israelachvili , 1985 , Inrtermolecular and surface forces-Academic press, London
6. I.B.Ivanov , 1988, Thin liquid films :Fundamentals and application-Marcel Dekkar , New York M.N.Ivanovskii V.P.Sorokin and I.V. Yagodkin , 1982 , The physical principles of heat pipes Clarendon press , Oxford

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE II
## REFRIGERATION AND AIR CONDITIONING

Course Code: GR14A5138 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Heat Transfer

**Course Objectives:** The course is intended to
- Familiarize students with the terminologies associated with refrigeration & air conditioning
- Cover the basic principles of psychometric and applied psychometrics
- Familiarize students with system analysis
- Familiarize students with load calculations and elementary duct design
- Familiarize students with refrigerants; vapor compression refrigeration and multi-stage vapor compression systems
- Understand the components of vapor compression systems and other types of cooling systems.

**Course Outcomes:** At the end of the course the learners will be able to
- Introduce students to HVAC technology, engineering, research, systems, system designs, energy impacts, and overall goals
- Develop understanding of the principles and practice of thermal comfort
- Develop understanding of the principles and practice and requirements of ventilation
- Develop generalized psychometrics of moist air and apply to HVAC processes
- Review heat transfer and solar energy engineering and develop techniques for the analysis of
  building envelope loads

**Unit-I**

**Vapour Compression Refrigeration:** Performance of Complete vapor compression system.

**Components of Vapor Compression System:** The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

**Compound Compression:** Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

**Unit-II**

**Production Of Low Temperature:** Liquefaction system ;Cascade System-Applications. Dry ice system. Vapor absorption system-Simple and modified aqua-ammonia system-Representation on Enthalpy concentration diagram. Lithium – Bromide system Three fluid system-HCOP.

**Unit- III**

**Air Refrigeration:** Applications-Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems-Problems based on different systems. Steam Jet refrigeration system: Representation on T-s and h-s diagrams-limitations and applications. Unconventional Refrigeration system-Thermo-electric-Vortex tube & Pulse tube-working principles.

**Unit-IV**

**AIR-Conditioning:** Psychrometric properties and processes – Construction of Psychrometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Summer , Winter and year round air – conditioning systems.

Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.

**Unit -V**

**AIR-Conditioning Systems:** All Fresh air , Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP,RSHF, ESHF and GSHF for different systems.

**Components:** Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Refrigeration & Air Conditioning /C.P. Arora/TMH
2. Refrigeration & Air Conditioning /Arora & Domkundwar/ Dhanpat Rai
3. Refrigeration and Air Conditioning /Manohar Prasad/

**Reference Books**

1. Refrigeration and Air Conditioning /Stoecker /Mc Graw Hill
2. Principles of Refrigeration/Dossat /Pearson
3. Refrigeration and Air Conditioning /Ananthanarayana /TMH
4. Refrigeration and Air Conditioning /Jordan& Preister /Prentice Hall
5. Refrigeration and Air Conditioning/Dossat /Mc Graw Hil

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE II
## JET PROPULSION AND ROCKETRY

Course Code: GR14A5139 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Turbo machines

**Course Objectives:** The course is intended to
- Develop an understanding of how air-breathing engines and chemical rockets produce thrust
- Analyze the overall engine performance
- Analyze the characteristics of the nozzle
- Carry out performance analysis rockets;
- Understanding of solid and liquid propellants engines

**Course Outcomes:** At the end of the course the learners will be able to
- The generation of thrust in air-breathing engines and rockets;
- The performance analysis engines
- The overall performance exhaust nozzles;
- An understanding of axial flow compressors and turbines, and an ability to carry out flow and performance calculations for these
- The simple performance calculations for rockets
- An understanding of how liquid and solid propellant rockets work.

**Unit-I**
**Turbo Jet Propulsion System:** Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.
**Flight Performance:** Forces acting on vehicle – Basic relations of motion – multi stage vehicles.

**Unit-II**
**Principles of Jet Propulsion and Rocketry:** Fundamentals of jet propulsion, Rockets and air breathing jet engines-Classification-turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.
**Nozzle Theory and Characteristics Parameters:** Theory of one dimensional convergent-divergent nozzles-aerodynamic choking of nozzles and mass flow through a nozzle-nozzle exhaust velocity-thrust, thrust coefficient, Ac / At of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria,

departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

**Unit-III**

**Aero Thermo Chemistry of the Combustion Products:** Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

Solid Propulsion System: Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

**Unit-IV**

Solid Propellant Rocket Engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.

**Liquid Rocket Propulsion System:** Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components. Design of combustion chamber, characteristic length, constructional features, and chamber wall stresses. Heat transfer and cooling aspects. Uncooled engines, injectors – various types, injection patterns, injector characteristics, and atomization and drop size distribution, propellant tank design.

**Unit-V**

**Ramjet and Integral Rocket Ramjet Propulsion System:** Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley & Sons
2. Rocket propulsion elements/Sutton/John Wiley & Sons/8th Edition
3. Gas Turbines/Ganesan /TMH

**Reference Books**

1. Gas Turbines & Propulsive Systems/Khajuria & Dubey/Dhanpat Rai & Sons
2. Rocket propulsion/Bevere/
3. Jet propulsion /Nicholas Cumpsty/

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE II
## THERMAL AND NUCLEAR POWER PLANTS

Course Code: GR14A5140 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Turbo machines

**Course Objectives:** The course is intended to
- Provide in awareness about resources of energies available in India for Power Production by Thermal and Nuclear Processes.
- Understand and know the requirements for a Thermal Power Plant and Nuclear Power Plant, from sources to consumption and economics of power plants.
- Study and learn the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants.
- Gain the knowledge on steam power plants, steam generators and gas turbine power plants, their analyses on fuel and fluidized bed combustion, ash handling systems,
- Learn the practices followed in Thermal Power Plant and Nuclear Power Plants, to better environmental conditions and the safety measures.
- Gain the knowledge on Power Load calculation, distribution and optimum loading. Etc.,
- Know various methods for the Economies of Power Generation and power plant instrumentation.

**Course Outcomes:** At the end of the course the learners will be able to:
- Gain the knowledge about resources of energies available in India for Power Production by Thermal and Nuclear Processes.
- Analyze the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants and identify the losses to get better efficiency.
- Apply the knowledge gained by analyzing the steam power plants, steam generators and gas turbine power plants, to improve the efficiency and reduce the thermal losses.
- Apply the knowledge in calculating the Power Load Calculations and Distribution.
- Develop the methods for the Economies of Power Generation and Power plant instrumentation

**Unit-I**

**Introduction:** Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis. Steam Power Plants: Introduction – General Layout of Steam Power Plant, Modern Coal-fired Steam Power Plants, Power Plant cycles, Fuel handling, Combustion Equipment, Ash handling, Dust Collectors.

Steam Generators: Types, Accessories, Feed water heaters, Performance of Boilers, Water Treatment, Cooling Towers, Steam Turbines, Compounding of Turbines, Steam Condensers, Jet & Surface Condensers.

**Unit - II**

**Gas Turbine Power Plant:** Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages.

**Unit -III**

**Nuclear Power Plants**: Nuclear Physics, Nuclear Reactors, Classification – Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants.

**Nuclear Power Plants Safety:** By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

**Unit -IV**

**Economics of Power Generation:** Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems.

**Unit-V**

**Power Plant Instrumentation:** Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution – Types, Methods to Control.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Power Plant Engineering / P.K. Nag / TMH.
2. Power Plant Engineering / R.K. Rajput / Lakshmi Publications.
3. Power Plant Engineering / P.C.Sharma / Kotaria Publications.
4. Power Plant Technology / Wakil.

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## THERMAL ENGINEERNG LAB

Course Code: GR14A5141 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Fluid Mechanics

**Course Objectives:** The lab is mainly intended to
- Analyze the performance and exhaust emissions of an IC engine by conducting the performance test on IC Engines.
- Evaluate the performance of the Vapor compression and Air conditioning units
- Analyze the flame propagation velocity of the gaseous fuels
- Evaluate the performance of the Solar flat plate collector and evacuated tube concentrator

**Course Outcomes:** At the end of the course the learners will be able to
- Analyze the performance and exhaust emissions of an IC engine
- Evaluate the performance of the Vapor compression and Air conditioning units
- Analyze the flame propagation velocity of the gaseous fuels
- Evaluate the performance of the Solar flat plate collector and evacuated tube concentrator

**Contents**
1. Compressibility factor measurement of different real gases.
2. Dryness fraction estimation of steam.
3. Flame propagation analysis of gaseous fuels.
4. Performance test and analysis of exhaust gases of an I.C. Engine.
5. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
6. COP estimation of vapour compression refrigeration test.
7. Performance analysis of Air conditioning unit.
8. Performance analysis of heat pipe.
9. Solar Flat Plate Collector

**Teaching methodologies**
1. Power Point presentations
2. Tutorial Sheets
3. Assignments

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## CONVECTIVE HEAT TRANSFER

Course Code: GR14A5142 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Heat Transfer

**Course Objectives:** The course is intended to
- Provide a fundamental treatment of fluid flows controlled by viscous or turbulent stress gradients and the subsequent heat transfer between fluids and solid surfaces.
- Provide analytical solutions to the momentum and energy conservation equations for both laminar and turbulent flows will be considered.
- Provide solid foundation for the engineering practitioner engaged in single phase convective thermal transport.
- Provide solid foundation for further studies in multiphase convective transport.

**Course Outcomes:** At the end of the course the learners will be able to
- To derive appropriate transport equations, apply transport equations to convective transport problems, and evaluate appropriate transport properties such as friction factors, Nusselt numbers, Sherwood numbers, and Stanton numbers.
- To understand and perform engineering analysis in the area of thermal systems.
- To evaluate the heat transfer coefficient for the engineering systems with natural convection.
- To evaluate the heat transfer coefficient for the engineering systems with forced convection inside

**Unit-I**
Introduction to Forced, free & combined convection – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers.
**Equations of Convective Heat Transfer:** Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

**Unit-II**

**External Laminar Forced Convection:** Similarity solution for flow over an isothermal plate– integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate.

**External Turbulent Flows:** Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate.

Internal Laminar Flows: Fully developed laminar flow in pipe, plane duct & ducts with other cross sectional shapes – Pipe flow & plane duct flow with developing temperature field – Pipe flows & plane duct flow with developing velocity & temperature fields.

**Internal Turbulent Flows:** Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

**Unit-III**

**Natural Convection:** Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

**Unit-IV**

**Combined Convection:** Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

**Unit-V**

**Convective Heat Transfer Through Porous Media:** Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow –Natural convection in porous media – filled enclosures – stability of horizontal porous layers.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Introduction to Convective Heat Transfer Analysis/ Patrick H. Oosthuigen & David Naylor/McGraw Hill
2. Convective Heat & Mass Transfer /Kays & Crawford/TMH

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## COMPUTATIONAL METHODS IN HEAT TRANSFER

Course Code: GR14A5143 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Numerical Methods(Engineering Mathematics)
- Fluid Mechanics
- Heat Transfer

**Course Objectives**
- Describe the physical significance of each term in the governing equations for CFD
- Become familiar with a commercial CFD package to solve practical CFD problems
- Quantify and analyze the numerical error in CFD discetization schemes
- Develop finite difference and finite volume forms of the CFD equations and important model systems
- Formulate explicit and implicit algorithms for solving the Navier-Stokes equations
- Construct computer code to solve the Navier-Stokes equations in 2-D
- Understand and apply verification strategies for evaluating CFD code

**Course Outcomes:** Upon completion of this course, students will be able to:
- To develop an understanding for the major theories, approaches and methodologies used in CFD;
- To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) in using commercial CFD codes;
- To gain experience in the application of CFD analysis to real engineering designs.
- Understand and apply the grid generation techniques for solving flow problems.

**Unit-I**
Introduction to Numerical Methods-Finite Difference, Finite Element and Finite Volume Methods-Classification of Partial Differential Equations-Solution of Linear Algebraic Equations – Direct and Iterative Approaches.
**Finite difference methods:** Taylor's series-FDE formulation for 1D and 2D steady state heat transfer problems-Cartesian, cylindrical and spherical co-ordinate systems-boundary conditions-Un steady state heat conduction- Errors

associated with FDE-Explicit Method-Stability criteria-Implicit Method-Crank Nickolson method- 2-D FDE formulation-ADI-ADE.

**Unit-II**

**Finite Volume Method:** Formation of Basic rules for control volume approach using 1D steady heat conduction equation – Interface Thermal Conductivity - Extension of General Nodal Equation to 2D and 3D Steady heat conduction and Unsteady heat conduction.

**Unit-III**

**FVM to Convection and Diffusion:** Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1D Convection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions.

**Unit-IV**

**Calculation of Flow Field:** Vorticity & Stream Function Method - Staggered Grid as Remedy for representation of Flow Field - Pressure and Velocity Corrections – Pressure Velocity Coupling - SIMPLE & SIMPLER (revised algorithm) Algorithm.

**Unit-V**

**Turbulent Flows:** Direct Numerical Simulation, Large Eddy Simulation and RANS Models Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Computational Fluid Flow and Heat Transfer – Muralidharan & Sundarajan (Narosa Pub)
2. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
4. Computational Fluid Dynamics – Anderson (TMH)
5. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)

**Reference Books**

1. Computational Fluid Dynamics, T.J. Chung, Cambridge University
2. Computational Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier)
3. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## ADVANCED I.C. ENGINES

Course Code: GR14A5144 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Concepts Of Thermodynamics
- Concepts Of Heat Transfer

**Course Objectives:** The course is intended to
- Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
- Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance
- Understand the delay period and fuel injection system
- Become aware of the relevance of environmental and social issues on the design process of internal combustion engines

**Course Outcomes:** At the end of the course the learners will be able to
- Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle
- Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance
- To Demonstrate the delay period and fuel injection system
- Demonstrate an understanding of the relationships between the design of the IC engine and environmental and social issues

**Unit-I**
**Introduction:** Historical Review – Engine Types – Design and operating Parameters.
Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

**Unit-II**
**Gas Exchange Processes:** Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.
Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

**Unit-III**

**Engine Combustion In S.i Engines:** Combustion and Speed – Cyclic Variations – Ignition –Abnormal combustion Fuel factors, MPFI, SI engine testing.
Combustion in CI engines: Essential Features – Types off Cycle. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

**Unit-IV**

**Pollutant Formation and Control:** Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, un burnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

**Unit -V**

**Engine Heat Transfer:** Importance of heat transfer, heat transfer and engine energy balance,Convective heat transfer , radiation heat transfer, Engine operating characteristics. Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.
Modern Trends in IC Engines: Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. I.C. Engines / V.Ganesan/TMH
2. I.C. Engines Fundamentals/Heywood/TMH
3. I.C. Engines/G.K. Pathak & DK Chevan/ Standard Publications
4. I.C. Engines /RK Rajput/Laxmi Publications

**Reference Books**

1. Computer Simulation of C.I. Engine Process/ V.Ganesan/University Press
2. Fundamentals of IC Engines/HN Gupta/PHI/2nd edition
3. I.C. Engines/Fergnson/Wiley
4. The I.C. Engine in theory and Practice Vol.I / Teylor / IT Prof. And Vol.II

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## EQUIPMENT DESIGN FOR THERMAL SYSTEMS

Course Code: GR14A5145 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Fluid Mechanics
- Heat Transfer

**Course Objectives:** The course is intended to
- Design and analyze the heat exchangers parallel flow, counter flow, multi pass and, cross flow heat exchanger
- Design and analyze the Shell and tube heat exchanger
- Enable to carry out the performance of heat exchanger with the extended surfaces.
- Design and analyze the cooling towers.

**Course Outcomes:** At the end of the course the learners will be able to
- Design and analyze the parallel flow, counter flow, multi pass and, cross flow heat exchangers
- Develop the Shell and tube heat exchanger
- Optimize the performance of heat exchanger.
- Design and analyze the cooling towers

**Unit -I**
**Classification of heat exchangers:** Introduction, Recuperation & Regeneration – Tubular heat exchangers: double pipe, shell & tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.
**Basic Design Methods of Heat Exchanger:** Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD method for heat exchanger analysis – parallel flow, counter flow, multi pass, cross flow heat exchanger design calculations.

**Unit-II**
**Double Pipe Heat Exchanger:** Film Coefficient for fluids in annulus, fouling factors, calorific temperature, average fluid temperature, the calculation of double pipe exchanger, Double pipe exchangers in series-parallel arrangements. Shell & Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film

coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performance of 1-2 heat exchanger, and design calculation of shell & tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

**Unit -III**

**Condensation of single vapors:** Calculation of a horizontal condenser, vertical condenser, De-super heater condenser, vertical condenser – sub-cooler, horizontal condenser – sub cooler, vertical reflux type condenser, condensation of steam.

**Unit-IV**

**Vaporizers, Evaporators and Reboilers:** Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler.

**Extended Surfaces:** Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.

**Unit-V**

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance, heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Process Heat Transfer – D.Q. Kern, TMH.
2. Cooling Towers by J.D. Gurney
3. Heat Exchanger Design – A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York.

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE III
## THERMAL MEASUREMENTS AND PROCESS CONTROLS

Course Code: GR14A5146 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Fluid Mechanics
- Heat Transfer

**Course Objectives:** The course is intended to
- Educate the student with operating principles and function of measuring instruments used in Engineering and process industries
- Make the student conversant with various working principles of instruments
- Understand and analyze the behavioral characteristics of instruments
- Make the student learn about calibration procedure the instrument
- Educate the student about the fundamental aspects of contro; systems and their use in the context of industry applications

**Course Outcomes:** At the end of the course the learners will be able to
- Making the student conversant with different working principles of various instruments
- Making the student to learn in the transduction of the signals
- Student can be able to analyze the behavior of an instrument in the measurement process
- Be able to analyze and design an instrumentation system, dealing with the concepts of dynamic range, signal noise ratio, and error budget
- Build, program, calibrate and use a microprocessor-based instrumentation system

**Unit-I**

**General Concepts:** Fundamental elements of a measuring instrument. Static and dynamic characteristics – errors in instruments – Different methods of measurement and their analysis – Sensing elements and transducers.

Measurement of pressure – principles of pressure measurement, static and dynamic pressure, vacuum and high pressure measuring – Measurement of low pressure, Manometers, Calibration methods, Dynamic characteristics- design principles.

**Unit-II**

**Measurement of Flow:** Obstruction meters, variable area meters. Pressure probes, compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments. Introduction to design of flow measuring instruments.

**Unit-III**

**Temperature Measurement:** Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers, Thermo positive elements, thermocouples in series & parallel, pyrometry, measurement of heat flux, calibration of temperature measuring instruments. Design of temperature measuring instruments.

**Unit-IV**

**Level Measurement:** Direct & indirect methods, manometric methods, float level meters, electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods.
Measurement of density – Hydrometer, continuous weight method, Gamma rays, Gas impulse wheel.
Velocity Measurement – Coefficient of viscosity, Ostesld method, free fall of piston under gravity, torque method. Measurement of moisture content and humidity. Measurement of thermal conductivity of solids, liquids and gases.

**Unit-V**

**Process Control:** Introduction and need for process control principles, transfer functions, block diagrams, signal flow graphs, open and closed loop control systems – Analysis of First & Second order systems with examples of mechanical and thermal systems. Control System Evaluation – Stability, steady state regulations, transient regulations.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Book**

1. Measurement System, Application & Design – E.O. Doeblin.

**Reference Books**

1. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
2. Mechanical Measurements – Buck & Beckwith – Pearson.
3. Control Systems, Principles & Design, 2nd Edition – M. Gopal – TMH.

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE III
## ALTERNATE ENERGY RESOURCES

Course Code: GR14A5147 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Fundamentals of Modern Physics
- Fundamentals Of Thermal And Design Engineering

**Course Objectives**
- To explain concept of various forms of renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications
- To analyse the environmental and cost economics of using renewable energy sources compared to fossil fuels.

**Course Outcome:** At the end of the semester the student will
- Have knowledge about various renewable energy sources
- Be able to choose the appropriate renewable energy as an alternate for conventional power in any application.
- Compare different renewable energy technologies and choose the most appropriate based on local conditions
- Perform simple techno economical assessments of renewable energy systems

**Unit -I**
**Introduction:** Energy Sinario - Survey of Energy Resources – Classification – Need for Non Conventional Energy Resources. Solar Energy: The Sun – Sun-Earth Relationship – Basic matter to waste heat energy circuit – Solar radiation – Attention – Radiation measuring instruments. Solar Energy Applications: Solar water Heating, space heating – active and passive heating – energy storage – selective surface – solar stills and ponds – solar refrigeration – photovoltaic generation .

**Unit-II**
**Geothermal Energy:** Structure of Earth – Geothermal Regions – Hot springs – Hot Rocks – Hot Aquifers – Analytical Methods to estimate Thermal Potential – Harnessing Techniques – Electricity Generating Systems.

**Unit -III**

**Direct Energy Conversion:** Nuclear Fusion: Fusion-Fusion Reaction- P-P Cycle carbon Cycle, Deuterium cycle-condition for controlled Fusion.Fuel Cells and Photovoltaic –Thermionic and Thermoelectric Generation- MHD Generator. Hydrogen gas a Fuel-Production methods-Properties-I.C. Engines Applications-Utilization Strategy-Performances.

**Unit-IV**

**Bio – Energy:** Biomass Energy Sources – Plant Productivity, Biomass Wastes – Aerobic and Anaerobic bio-conversion processes – Raw Materials and properties of Bio-gas-Bio-gas plant Technology and Status – The Energetics and Economics of Biomass Systems – Biomass gasification.

**Unit-V**

**Wind Energy:** Wind – Beaufort number – characteristics – wind energy conversion systems – types – Betz model – Interference Factor – Power Coefficient – Torque Coefficient and thrust coeff.- Lift machines and drag machines – matching – electricity generation.

**Energy from Oceans:** Tidal Energy; Tides – Diurnal and Semi – Diurnal Nature – Power from Tides. Wave Energy ; Waves – Theoretical Energy Available – Calculation of period and phase velocity of waves – wave power systems – submerged devices.

**Ocean Thermal Energy :** principles – Heat Exchangers – Pumping requirements – Practical Considerations.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Book**

1. Renewable Energy Resources – Basic Principles and Applications – G.N.Tiwari and M.K.Ghosal, Narosa Pub

**Reference Books**

1. Renewable Energy Resources / John Twidell & Tony Weir
2. Biological Energy Resources / Malcolm Flescher & Chrris Lawis

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE III
## CRYOGENIC ENGINEERING

Course Code: GR14A5148 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Fundamentals of thermodynamics

Course Objectives
- To understand the principles of cryogenic systems
- To understand the principles of liquefaction systems
- To understand the principles of cryogenic refrigeration systems

**Course Outcome:** At the end of the semester the student will
- Have knowledge about various cryogenic engineering applications to space technology

**Unit-I**
Introduction to CRYOGENIC Systems – Mechanical Properties at low temperatures – Properties of cryogenic fluids.
Gas Liquefaction: Minimum work for liquefaction – Methods to produce low temperature – Liquefaction systems for gases other than Neon, Hydrogen and Helium

**Unit-II**
Liquefaction systems for Neon, Hydrogen and Helium Components of Liquefaction systems – Heat Exchangers – Compressors and Expanders – expansion valve – Losses for real machines

**Unit-III**
Gas separation and purification systems – Properties of mixtures – Principles of mixtures – Principles of gas separation – Air separation systems

**Unit-IV**
Cryogenic Refrigeration Systems – Working media – Solids, Liquids and gases
Cryogenic fluid storage & transfer – Cryogenic storage systems – Insulation – Fluid transfer mechanisms – Cryostat – Cryo Coolers

**Unit-V**
Applications – Space technology – In-flight air seperation and collection of LOX – Gas Industry – Biology – Medicine - Electronics

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Book**

1. Cryogenic Systems – R.F. Barron, Oxford University Press

**Reference Books**

1. Cryogenic Research and Applications – Marshall Sitting, Von Nostrand Inc, New Jersey
2. Cryogenics Engineering Edit by B.A.Hands, Academic Press, 1986
3. Cryogenics Engineering – R. B. Scott, Von Nostrand Inc, New Jersey, 1959
4. Experimental Techniques in Low Temperature Physics – G.K. White, Oxford Press, 1968
5. Cryogenics process Engineering – K.D.Timmerhaus & TM Flynn, Plenum press, 1998
6. Cryogenic Heat Transfer - R.F. Baron.
7. Cryogenic Two Phase flow – N.N . Falina and J.G. Weisend –II
8. Cryogenic Regenerative Heat Exchangers – Robort Ackermann, Plenum Press, 1997
9. Cryogenic Engineering – Thomas M. Flynn
10. Safety in Handling of Cryogenic Fluids – Fredrick J. Edeskutty and Watter F. Stewart, Plenum Press,
11. Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE IV
## FUELS, COMBUSTION AND ENVIRONMENT

Course Code: GR14A5149 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Fundamentals of thermodynamics

**Course Objectives:** The course is intended to
- Provide students with knowledge of fuel quantity and engine technology effects on emissions.
- Understand the combustion phenomena.
- Understand the concept of laminar and turbulent flame propagation.
- Understand about different methods to reduce air pollution

**Course Outcomes:** Upon completion of the subject, students will be able to:
- Have the knowledge of fuel thermo-chemistry and fuel quality effects on emissions, engine technologies, engine combustion-related emissions and control technologies;
- Extend their knowledge of fuels and engines to different situations of engineering context and professional practice.
- Have recognition of the need for, and an ability to engage in life-long learning.

**Unit-I**
Fuels - Detailed Classification – Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal. Coal – Carborisation, Gasification and liquification – Lignite: petroleum based fuels – problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas Alcohols and Biogas.

**Unit-II**
Principles of Combustion – Chemical composition – Flue gas anlaysis – dew point of products – Combustion stoichiometry. Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroth, first, second and third order reactions - complex reactions – chain reactions. Theories of reaction Kinetics – General oxidation behavior of HC’s.

**Unit-III**
Thermodynamics of Combustion – Enthalpy of formation – Heating value of fuel - Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

**Unit-IV**
Laminar and Turbulent flames Propagation and Structure – Flame stability – Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity. Combustion of fuel, droplets and sprays – Combustion systems – Pulverised fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

**Unit-V** Environmental Considerations – Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

**Teaching methodologies**
1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Book**
1. Combustion Fundamentals by Roger A strehlow – Mc Graw Hill

**Reference Books**
1. Fuels and combustion by Sharma and Chander Mohan – Tata Mc Graw Hill
2. Combustion Engineering and Fuel Technology by Shaha A.K. Oxford and IBH.
3. Principles of Combustion by Kanneth K.Kuo, Wiley and Sons.
4. Combustion by Sarkar – Mc. Graw Hill.
5. An Introduction to Combustion – Stephen R. Turns, Mc. Graw Hill International Edition.
6. Combustion Engineering – Gary L. Berman & Kenneth W. Ragland, Mc. Graw Hill International Edition.
7. Combustion- I. Glassman

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE IV
## MULTI PHASE FLOW

Course Code: GR14A5150 L:3 T:0 P:0 C:3
I Year II Semester

**Prerequisites**
- Fundamentals of thermodynamics

**Course Objectives:** The course is intended to
- Provide students with knowledge of two phase flows.
- Understand the flow phenomena.
- Understand the concept of laminar and turbulent flow propagation.
- Understand about different phase change process

**Course Outcomes:** Upon completion of the subject, students will be able to:
- Understand the thermo fluidic aspects of a two phase flows

**Unit-I**
**Introduction:** multi phase and multi-component flow, practical examples; method of analysis of multi phase and multi-component flow problems; basic definitions; two phase, one-dimensional conservation equations; pressure gradient components; flow patterns, Two phase flow patterns in mini and micro-channels.

**Unit-II**
Basic flow models – homogeneous flow model, pressure gradient, two phase friction factor for laminar flow and turbulent flow, two phase viscosity, friction multiplier; separated flow model – pressure gradient, Lokhart Martinelli correlation; Multidimensional two fluid model.

**Unit -III**
Drift flux model – gravity dominated flow regime, corrections for void fraction and velocity distribution in different flow regimes, pressure loss due to multi phase flow in pipe fittings, velocity and concentration profile in multi phase flow; one-dimensional waves in two component flow, void-quality correlations.

**Unit-IV**
Boiling and condensation – evaporation, nucleate boiling, convective boiling; bubble formation and limiting volume; boiling map; DNB; critical boiling conditions ; static and dynamic instabilities.

**Unit-V**

Condensation process– types of condensation, Nusselt theory, deviations from Nusselt theory, practical equations, condensation of flowing vapors; introduction to boiling and condensation in small passages.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Textbooks**

1. Collier, J. G., Convective Boiling and Condensation, McGraw-Hill, 1981.
2. Wallis, G. W., One-dimensional Two Phase Flow, McGraw-Hill, 1969.
3. Stephen, K. Heat Transfer in Condensation and Boiling, Berlin Hiedelberg, 1992.
4. Hsu, Y. Y. and Graham, R. W., Transport Processes in Boiling and Two phase Systems, McGraw-Hill, 1976.

**Reference Books**

1. Ginoux, J. J., Two Phase Flows and Heat Transfer, McGraw-Hill, 1978.
2. Hewitt, G., Delhaye, J. M., and Zuber, N., Multiphase Science and Technology, Vol. I, McGraw-Hill, 1982.
3. Ghiaasiaan, S. M., Two-Phase Flow, Boiling and Condensation: In Conventional and Miniature Systems, Cambridge University Press, 2008.
4. Tong, L. S. and Tang, Y. S., Boiling Heat Transfer and Two-Phase Flow, second Edition, Taylor & Francis, 1997.

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY
## ELECTIVE IV
## SOLAR ENERGY TECHNOLOGY

Course Code: GR14A5151 L:3 T:0 P:0 C:3
I Year I Semester

**Prerequisites**
- Fundamentals of Thermodynamics
- Fundamentals Of Heat Transfer

**Course Objectives**
- To explain concept of various forms of renewable energy
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications
- To analyze the environmental and cost economics of using renewable energy sources compared to fossil fuels.

**Course Outcomes:** At the end of the semester the student will
- Have knowledge about various solar energy applications
- Be able to choose the appropriate renewable energy as an alternate for conventional power in any application.
- Compare different solar energy technologies and choose the most appropriate based on local conditions
- Perform simple techno economical assessments of solar energy systems

**Unit-I**

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.

**Unit-II**

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.

**Unit- III**

**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.

**Unit-IV**

**Direct Energy Conversion:** solid-state principles – semiconductors – solar cells –performance – modular construction – applications. conversion efficiencies calculations.

**Unit-V**

**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.

**Teaching methodologies**

1. Power Point presentations
2. Tutorial Sheets
3. Assignments

**Text Books**

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/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
4. Solar energy/ Garg/TMH

**Reference Books**

1. Solar energy/ Magal/Mc Graw Hill
2. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa
3. Power plant Technology/ El Wakil/TMH

# GOKARAJU RANGARAJU
## INSTITUTE OF ENGINEERING AND TECHNOLOGY

## COMPUTATIONAL METHODS LABORATORY

Course Code: GR14D5058 L:0 T:0 P:3 C:2
I Year II Semester

**Course Objectives:** The lab is mainly intended to:
- Familiarize the usage of CFD software package.
- Reduce the time for solving different fluid flow problems.
- Model the heat transfer problems where fluid flow is present in CFD software package such as ansys and gambit.
- Analyze the different thermal systems for variable fluid flow properties such as mass flow rate,Reynolds number etc.
- Analyze the thermal systems under different flow conditions such as turbulent flow etc.
- Correlating the results obtained using different software with theoretical knowledge.
- Identify the critical situation where the fluid flow can affect the thermal system.

**Course Outcomes:** At the end of the lab the learners will be able to:
- Understand the basics on how to use CFD software package for fluid flow problems.
- Understand how a software package can reduce time to solve a fluid flow problem.
- Model the different thermal systems used in real world.
- Analyze the thermal systems by varying the fluid flow properties of the system.
- Identify the critical situations of the thermal system.
- To handle projects related to fluid flow.

**CFD List of Experiments**
1. Simple thermal system modeling and analysis
2. Fluid Flow and Heat Transfer analysis in a Mixing Elbow
3. Periodic simulation of 2-D heat exchanger using Fluent and correlating the results with theoretical results.
4. Simulation of 3-D heat exchanger
5. Analysis of turbulent flow past a transonic airfoil
6. Analysis of Transient Temperature Distribution in a Slab.
7. Analysis of Temperature Distribution on an Insulated Wall.
8. Analysis of Temperature Distribution along a Straight Fin.

9. Analysis of Temperature Distribution along a Tapered Fin.
10. Analysis of Discharge of Water from a Reservoir.

**Solving the above Thermal Engineering problems using available packages such as Gambit ,ANSYS ,CFX, STARCD, MATLAB, FLUENT, ABAQUS**