# ACADEMIC REGULATIONS

# COURSE STRUCTURE

# AND SYLLABUS

For

## M.Tech. (Mechanical Engg.)

with

## THERMAL ENGINEERING SPECIALISATION

*(Applicable for the batches admitted from 2011-12)*



## MALLA REDDY ENGINEERING COLLEGE
*(Autonomous)*
**Maisammaguda, Hyderabad-500014**
**Affiliated to**
**Jawaharlal Nehru Technological University Hyderabad**
**Hyderabad**

**MALLA REDDY ENGINEERING COLLEGE**
**(Autonomous)**
**Hyderabad -** 500 014 A.P.
**August/September 2011**

**Academic Regulations 2011 for M.Tech. (Regular)**
(*Effective for the students admitted into first year from the academic year 2011-2012*)

The M.Tech Degree of Malla Reddy Engineering College, Hyderabad shall be conferred on candidates by the Jawaharlal Nehru Technological University Hyderabad, Hyderabad who are admitted to the program and fulfill all the requirements for the award of the Degree.

**1.0    ELIGIBILITY FOR ADMISSIONS:**

Admission to the above program shall be made subject to the eligibility, qualifications and specialization prescribed by the university/college from time to time.

Admissions shall be made on the basis of merit rank obtained by the qualifying candidate at an Entrance Test conducted by the university/college or on the basis of any other order of merit approved by the university/college (say PGECET), subject to reservations prescribed by the university/college from time to time.

**2.0    AWARD OF M. TECH. DEGREE:**

2.1 A student shall be declared eligible for the award of the M.Tech degree, if he pursues a course of study and completes it successfully for not less than two academic years and not more than four academic years.

2.2 A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his admission, shall forfeit his seat in M.Tech course.

2.3 The minimum instruction for each semester 90 clear instruction days.

**3.0  A. COURSE OF STUDY:**
The following specializations are offered at present for the M.Tech course of study.
.
1. Computer Science and Engineering
2. Control Systems
3. Control Engineering
4. Structural Engineering
5. Thermal Engineering
6. Digital Systems & Computer Electronics

and any other course as approved by the authorities of the university/college from time to time.

**3.0  B.  Departments offering M. Tech Programs with Specializations mentioned below:**

| | |
|---|---|
| Civil Engineering Department | Structural Engineering |
| Computer Science & Engg. Department | Computer Science & Engg. |
| Electrical Electronics Engg. Department | Control Systems |
| -do- | Control Engineering |
| Electronics & Communication Engineering Department | Digital Systems & Computer Electronics |
| Mechanical Engineering Department | Thermal Engineering |

**4.0 ATTENDANCE:**

The programs are offered on a unit basis with each subject being considered unit.

**4.1**   A candidate shall be deemed to have eligibility to write end semester examinations in a subject if he has put in at least 75% of attendance in that subject.

**4.2**  Shortage of attendance up to 10% in any subject (i.e. 65% and above and below 75%) may be condoned by the College Academic Committee on genuine and valid reasons on representation by the candidate with supporting evidence.

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

**4.4**  Shortage of attendance below 65% shall **in no case be condoned**.

**4.5**  A stipulated fee shall be payable towards condonation of shortage of attendance.

## 5.0   EVALUATION:

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practical, on the basis of Internal Evaluation and End Semester Examination.

**5.1**    For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination, 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the better of the marks secured in the two Mid Term-Examinations conducted one in the middle of the Semester and the other immediately after the completion of instruction each for a total of 30 marks.  Each mid term examination shall be conducted for a duration of 120 minutes with 4 questions to be answered out of 6 questions.  In addition, there shall be two assignments evaluated for 10 marks each and average of the two taken as the final assignment mark.  The sum of the best of the two mid examinations and the assignment marks obtained shall be the final marks for internal evaluation.

**5.2**    For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations, 40 marks shall be awarded based on the day-to-day performance as internal Marks.

**5.3**    There shall be two seminar presentations during I year I semester and II Semesters. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The Departmental Committee consists of Head of the Department, supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful.

**5.4**    There shall be a Comprehensive Viva-Voce in II year I Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members in that area of specialisation. The Comprehensive Viva-Voce is aimed to assess the students' 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

**5.5**    A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

**5.6**    In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.4) he has to reappear for the End Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and he has failed in the end examination. In such case candidate must re-register for the subject(s) and secure required minimum attendance. Attendance in the re-registered subject(s) has to be calculated separately to become eligible to write the end

examination in the re-registered subject(s). The attendance of re-registered subject(s) shall be calculated separately to decide upon the eligibility for writing the end examination in those subject(s). In the event of taking another chance, the internal marks and end examination marks obtained in the previous attempt are nullified.

**5.7** In case the candidate secures less than the required attendance in any subject(s), he shall not be permitted to appear for the End Examination in that subject(s). He shall re-register the subject when next offered.

**5.8** Laboratory examination for M.Tech courses must be conducted with two Examiners, one of them being Laboratory Class Teacher and second examiner shall be other Laboratory Teacher or any other member from inside/outside of the college.

## 6.0    EVALUATION OF PROJECT/ DISSERTATION WORK:

Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the Project Review Committee.

**6.1** A Project Review Committee (PRC) shall be constituted with Principal as chair person Heads of all the Departments which are offering the M.Tech programs and two other senior faculty members.

**6.2** 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).

**6.3** After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the Departmental Committee for its approval. Only after obtaining the approval of Departmental Committee the student can initiate the Project work.

**6.4** If a candidate wishes to change his supervisor or topic of the project he can do so with approval of Departmental Committee. However, the Departmental Committee 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.

**6.5** Candidate shall submit status report (in a bound-form) in two stages at least with a gap of 3 months between them.

**6.6** 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. A candidate is permitted to submit Project Thesis 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 thesis to the Principal (through Head of the Department) and shall make an oral presentation/demonstration  before the PRC.

**6.7** Three copies of the Project Thesis certified by the supervisor shall be submitted to the College / School/ Institute.

**6.8** The thesis shall be adjudicated by one examiner selected by the College. For this, Head of the Department shall submit a panel of 5 examiners to the Principal of the College, who are eminent in that field with the help of the concerned guide and Head of the department.

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

**6.10** 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 Thesis. 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 fails to get a satisfactory report at the second viva-voce examination, he will not be eligible for the award of the degree.

## 7.0 AWARD OF DEGREE AND CLASS:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

| Class Awarded | % of marks to be secured |
|---|---|
| First Class with Distinction | 70% and above |
| First Class | Below 70% but not less than 60% |
| Second Class | Below 60% but not less than 50% |
| Pass Class | Below 50% but not less than 40% |

(The marks in internal evaluation and end examination shall be shown separately in the marks memorandum)

**8.0  WITH-HOLDING OF RESULTS:**

If the candidate has not paid any dues to the university or if any case of in-discipline is pending against him, the result of the candidate will be withheld and he will not be allowed into the next higher semester. The issue of the degree is liable to be withheld in such cases.

**9.0  TRANSITORY REGULATIONS:**

Candidate who have discontinued or have been detained for want of attendance or who have failed after having undergone the course are eligible for admission to the same or equivalent subjects as and when subjects are offered, subject to rule 5.5 and 2.0 of these regulations.

**10.0  GENERAL:**

**10.1** The academic regulations should be read as a whole for purpose of any interpretation.

**10.2**  In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

**10.3** The College may change or amend the academic regulations and syllabus at any   time and the changes and amendments made shall be applicable to all the students with  effect from the date notified by the University/College.

**10.4** Wherever the word he, him or his occur, it will also include she, her and hers.

 **10.5** There shall be no transfers within the constituent colleges of Jawaharlal Nehru Technological University.

**2011-12**

# MALLA REDDY ENGINEERING COLLEGE
## (Autonomous)
# M.Tech (THERMAL ENGINEERING)
# COURSE STRUCTURE

**I YEAR –I SEMESTER**

| Code No: | Subject | L | T | P | Internal val | End Exam | Total |
|---|---|---|---|---|---|---|---|
| THR511101 | Optimization Techniques & Applications | 3 | 1 | 0 | 40 | 60 | 100 |
| THR511102 | Advanced Thermodynamics | 3 | 1 | 0 | 40 | 60 | 100 |
| THR511103 | Advanced Heat & Mass Transfer | 3 | 1 | 0 | 40 | 60 | 100 |
| THR511104 | Advanced Fluid Mechanics | 3 | 1 | 0 | 40 | 60 | 100 |
| THR511105 THR511106 THR511107 | **Elective-I** 1.Turbo- Machines 2.Cryogenics Engineering 3.Solar Energy Technology | 3 | 1 | 0 | 40 | 60 | 100 |
| THR511108 THR511109 THR511110 | **Elective-II** 1.Advanced I.C Engines 2.Non-Conventional Energy Sources 3.Material Science | 3 | 1 | 0 | 40 | 60 | 100 |
| THR511111 | Thermal Engineering Lab | 0 | 0 | 3 | 40 | 60 | 100 |
| THR511112 | Seminar | _ | _ | _ | 50 | - | 50 |
|  | Total   Marks |  |  |  |  |  | 750 |

**I YEAR –II SEMESTER**

| Code No: | Subject | L | T | P | Internal val | End Exam | Total |
|---|---|---|---|---|---|---|---|
| THR521101 | Fuel Combustion & Environment | 3 | 1 | 0 | 40 | 60 | 100 |
| THR521102 | Energy Management | 3 | 1 | 0 | 40 | 60 | 100 |
| THR521103 | Finite Element Analysis | 3 | 1 | 0 | 40 | 60 | 100 |
| THR521104 | Computational Fluid Dynamics | 3 | 1 | 0 | 40 | 60 | 100 |

| | | | | | Internal val | End Exam | |
|---|---|---|---|---|---|---|---|
| THR521105 | **Elective-III** 1.Equipment Design for Thermal Systems | 3 | 1 | 0 | 40 | 60 | 100 |
| THR521106 | 2.Convective Heat Transfer | | | | | | |
| THR521107 | 3.Thermal & Nuclear Power plants | | | | | | |
| THR521108 | **Elective-IV** 1.Thermal Measurements and Process Controls | 3 | 1 | 0 | 40 | 60 | 100 |
| THR521109 | 2.Refrigeration & Air Conditioning | | | | | | |
| THR521110 | 3.Jet Propulsion & Rocketry | | | | | | |
| THR521111 | Computational Methods Lab | 0 | 0 | 3 | 40 | 60 | 100 |
| THR521112 | Seminar | _ | _ | _ | 50 | - | 50 |
| | Total  Marks | | | | | | 750 |

**II YEAR –I SEMESTER**

| Group | Subject | L | T | P | Internal val | End Exam | Total |
|---|---|---|---|---|---|---|---|
| | Seminar | 0 | 0 | 3 | | | |
| THR521113 | Comprehensive Viva Voce | - | - | - | | 100 | 100 |
| THR521114 | Project – Part I | - | - | - | | | |
| | Total Marks | | | | | | 100 |

**II YEAR –II SEMESTER**

| Group | Subject | L | T | P | Internal val | End Exam |
|---|---|---|---|---|---|---|
| THR521114 | Project Part  II & Dissertation | - | - | - | | **Grade** |
| | Total   Marks | | | | | Grade |

Grade:   A-Excellent.            B-Good.

C-Satisfactory.         D-Unsatisfactory.

Note: All End Examinations (Theory and Practical) are of three hours durations.

L – Theory.            T – Tutorial.          P – Practical.

**MALLA REDDY ENGINEERING COLLEGE (Autonomous)**


**M. Tech. I Year. I Semester**                                   **L   T/P/D**
                                                                 **3   1/-/-**


## OPTIMIZATION TECHNIQUES AND APPLICATIONS

**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 opt imization: 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.

**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

## MALLA REDDY ENGINEERING COLLEGE (Autonomous)

**M. Tech. I Year. I Semester**                                                    **L   T/P/D**
                                                                                                     **3    1/-/-**

## ADVANCED THERMO DYNAMICS

**Unit - 1:**
**Review of Thermo dynamic Laws and Corollaries** – Transient Flow Analysis – Second law of thermodynamics – Entropy - Availability and unavailability – Irreversibility – Thermo dynamic Potentials – Maxwell Relations – Specific Heat Relations – Mayer's relation - Evaluation of Thermodynamic properties of working substance

**Unit - 2:**
**P.V.T. surface** – Equations of state – Real Gas Behaviour – Vander Waal's equation - Generalised compressibility Factor – Energy properties of Real Gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient.
Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties – Pychrometric Mixture properties and psychrometric chart – Air conditioning processes – Cooling Towers – Real Gas Mixture.

**Unit – 3 :**
**Combustion** – Combustion Reactions – Enthalpy of Formation – Entropy of
Formation – Reference Levels for Tables – Energy of formation – Heat of Reaction – Aiabatic flame Temperature General product – Enthalpies – Equilibrium.
Chemical Equilibrium of Ideal Gases – Effects of Non-reacting Gases Equilibrium in Multiple Reactions. The vant Hoff's Equation. The chemical potential and phase Equilibrium – The Gibbs phase Rule.

**Unit - 4:**
**Power cycles**, Review Binary vapour cycle, co-generation and
Combined cycles – Second law analysis of cycles – Refrigeration cycles.
Thermo Dynamics off irreversible processes – Introduction – phenomenological laws – Onsagar Reciprocity Relation – Applicability of the phenomenological Relations – Heat Flux and Entropy Production – Thermo dynamic phenomena – Thermo electric circuits.

**Unit - 5:**
**Direct Energy Conversion Introduction** – Fuel Cells - Thermo electric energy – Thermo-ionic power generation -Thermodynamic devices Magneto Hydrodynamic Generations – Photo voltaic cells.

## TEXT BOOKS :

1. Basic and Applied Thermodynamics, P.K. Nag, TMH
2. Thermo dynamics / Holman, Mc Graw Hill

## REFERENCE BOOKS :

1. Thermo dynamics / Doolittle – Messe
2. Thermo dynamics / Sonnatag & Van Wylen
3. Irreversible Thermo Dynamics / HR De Groff.
4. Engg. Thermo dynamics /PL.Dhar

**MALLA REDDY ENGINEERING COLLEGE (Autonomous)**
M. Tech. I Year. I Semester                                                           L   T/P/D
                                                                                                  3   1/-/-

### ADVANCED HEAT AND MASS TRANSFER

**UNIT- 1**:
**Brief Introduction to different modes of heat transfer**; Conduction: General heat conduction equation-Initial and Boundary conditions
**Steady State Heat Transfer**: Simplified heat transfer in 1D and 2D – Fins
**Transient heat conduction**; Lumped system analysis- Heisler charts-semi infinite solid-use of shape factors in conduction - 2D transient heat conduction – product solutions

**UNIT - 2:**
**Finite Difference methods for Conduction**: 1D & 2D steady state and simple transient heat conduction problems – implicit and explicit methods.
**Forced Convection**: Equations of Fluid Flow – Concepts of Continuity, momentum equations – Derivation of Energy equation - Methods to determine heat transfer coefficient: Analytical Methods - Dimensional Analysis and concept of exact solution. Approximate Method – Integral analysis

**UNIT - 3:**
**External flows**: Flow over a flat plate: Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometrics for Laminar and Turbulent flows.
**Internal flows**: Fully developed flow: Integral analysis for laminar heat transfer coefficient – Types of flow – Constant Wall Temperature and Constant Heat Flux Boundary Conditions - Hydrodynamic & thermal entry lengths; use of empirical correlations.

**UNIT - 4:**
**Free convection:** Approximate analysis on laminar free convective heat transfer – Boussinesque Approximation - Different geometries – combined free and forced convection
**Boiling and condensation**: Boiling curve – Correlations- Nusselt's theory of film condensation on a vertical plate – Assumptions & correlations of film condensation for different geometrics.

**UNIT - 5:**
**Radiation Heat Transfer:** Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation – radiation from flames.
**Mass Transfer**: Concepts of mass transfer – Diffusion & convective mass transfer Analogies – Significance of non-dimensional numbers.

### 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
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

**MALLA REDDY ENGINEERING COLLEGE (Autonomous)**


**M. Tech. I Year. I Semester**                                                **L   T/P/D**
                                                                                           **3   1/-/-**


**ADVANCED FLUID MECHANICS**

**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 Cartesystems normal and tangential accelerations, Euler's, Bernouli equations in 3D– Continuity and Momentum Equations
**UNIT 2:**
**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 3:**
**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 4:**
**UNIT I: 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 5:**
**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.

**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

**MALLA REDDY ENGINEERING COLLEGE (Autonomous)**
**M. Tech. I Year. I Semester**                                            **L   T/P/D**
                                                                          **3   1/ -/ -**
### ELECTIVE I
### TURBO MACHINES

**Unit – 1:**
**Fundamentals of Turbo machines:**        Classification, Applications Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiencies; static and Stagnation conditions; continuity equation; Euler's flow through variable cross sectional area; unsteady flow in turbo machines.

**Unit –2:**
**Steam Nozzles:** Convergent and Convergent – Divergent nozzles; Energy balance; effect of back – pressure on the analysis; Design of nozzles.
**Steam Turbines :**Impulse Turbines: Compounding; work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height; Secondary flow; leakage losses; Thermodynamic analysis of steam turbines.

**Unit – 3:**
**Gas Dynamics:** Fundamentals thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves ; normal shock recovery ; detached shocks ; Aerofoil theory.
**Centrifugal Compressor**: Types; Velocity triangles and efficiencies; Blade passage design; Diffuser and pressure recovery; slip factor; stanitz and stodolas formulae; Effect of inlet mach number; Prewirl; performance.

**Unit – 4:**
**Axial Flow Compressors:** Flow analysis, work and velocity triangles ; Efficiencies; Thermodynamic analysis; stage pressure rise ; Degree of reaction ; stage loading ; general design, effect of velocity incidence ; performance.
**Cascade Analysis:** Geometry and Terminology; Blade forces, Efficiency; losses; free and forced vortex blades.

**Unit – 5:**
**Axial Flow Gas Turbines:** Work done; velocity triangles and efficiencies; thermodynamic flow analysis; degree of reaction; Zweifels relation; Design cascade analysis – Soderberg – Hawthrone – ainley-correlations; secondary flow; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disc theory; stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

**TEXTBOOKS :**

1)  Fundamentals of Turbo machines – Shephard
2)  Practise on Turbomachines – G. Gopalakrishnan & D. Prithviraj, SciTech Publishers, Chennai.

**REFERENCE BOOKS :**

1. Theory and practice of steam turbines – Kearton
2. Gas Turbines – Theory and practice – Zucrow
3. Elements of Gas Dynamics – Liepman and Roshkow
4. Elements of Gas Dynamics – Yahya
5. Turbines, Pumps, Compressors – Yahya
6. Axial Flow Compressors – Horlock.
7. Gas Turbines- Cohen, Roger & Sarvanamuttu

**MALLA REDDY ENGINEERING COLLEGE (Autonomous)**
**M. Tech. I Year. I Semester**                                            **L   T/P/D**
                                                                          **3   1/-/-**

**ELECTIVE I**
**CRYOGENIC ENGINEERING**

**UNIT - 1:** 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 - 2:** Liquefaction systems for Neon, Hydrogen and Helium Components of Liquefaction systems – Heat Exchangers – Compressors and Expanders – expansion valve – Losses for real machines

**UNIT - 3:** Gas separation and purification systems – Properties of mixtures – Principles of mixtures – Principles of gas separation – Air separation systems

**UNIT - 4:** Cryogenic Refrigeration Systems – Working media – Solids, Liquids and gases Cryogenic fluid storage & transfer – Cryogenic storage systems – Insulation – Fluid transfer mechanisms – Cryostat – Cryo Coolers

**UNIT - 5:** Applications – Space technology – In-flight air seperation and collection of LOX – Gas Industry – Biology – Medicine - Electronics

**TEXT BOOKS:**
1. Cryogenic Systems – R.F. Barron, Oxford University Press
2. Cryogenic Research and Applications – Marshall Sitting, Von Nostrand Inc, New Jersey

**REFERENCE BOOKS:**
1. Cryogenics Engineering Edit by B.A.Hands, Academic Press, 1986
2. Cryogenics Engineering – R. B. Scott, Von Nostrand Inc, New Jersey, 1959
3. Experimental Techniques in Low Temperature Physics – G.K. White, Oxford Press, 1968
4. Cryogenics process Engineering – K.D.Timmerhaus & TM Flynn, Plenum press, 1998
5. Cryogenic Heat Transfer - R.F. Baron.
6. Cryogenic Two Phase flow – N.N . Falina and J.G. Weisend –II
7. Cryogenic Regenerative Heat Exchangers – Robort Ackermann, Plenum Press, 1997
8. Cryogenic Engineering – Thomas M. Flynn
9. Safety in Handling of Cryogenic Fluids – Fredrick J. Edeskutty and Watter F. Stewart, Plenum Press, 1996
10. Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998

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## SOLAR ENERGY TECHNOLOGY
## (ELECTIVE I)

**Unit - 1:**

**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 - 2:**

**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.

**Unit - 3:**

**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.

**Unit - 4:**

**Direct energy conversion** – solid-state principles – semiconductors – solar cells – performance – modular construction – applications.

**Unit - 5:**

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

**TEXT BOOKS:**
1. Principles of solar engineering – Kreith and Kerider
2. Solar energy thermal processes – Duffie and Beckman
3. Solar energy – Sukhatme

**REFERENCE BOOKS:**
1. Solar energy – Garg
2. Solar energy – Magal
3. Soloar energy – Tiwari and Suneja
4. Power plant technology – El Waki

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**ELECTIVE II**
**ADVANCED  I.C. ENGINES**

</div>

**UNIT - 1:** 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 - 2: 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 - 3: 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 - 4: Pollutant Formation and Control:** Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

**UNIT - 5:**
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

**TEXT BOOKS:**

1. I.C. Engines Fundamentals/Heywood/Mc Graw Hill
2. The I.C. Engine in theory and Practice Vol.I / Teylor / IT Prof. And   Vol.II

**REFERENCES BOOKS:**

3. I.C. Engines: Obert/Int – Text Book Co.
4. I.C. Engines: Maleev

5.  Combustion Engine Processes: Lichty
6.  I.C. Engines: Ferguson
7.  Scavenging of Two – stroke Cycle Engines – Switzer.
8.  I.C.Engines by V.Ganesan

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**ELECTIVE II**
**NON CONVENTIONAL ENERGY RESOURCES**

**Unit – 1:   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 - 2: 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 - 3:   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 – 4:   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 – 5: 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.

**TEXT BOOKS:**

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

**REERENCE BOOKS :**

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

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## MATERIAL SCIENCE
## (ELECTIVE II)

**UNIT 1:**
Introduction–Materials used in Thermal Engineering applications.  Stainless steels, Cast Iron,
**UNIT 2:**
Super Alloys and Titanium and its alloys .Graphite, Oxide Ceramides, Borides
**UNIT 3:**
Nitrides ,Silicides, Refractory Metals and alloys ( W, Ta, Cb, Rh & Mo)
**UNIT 4:**
Cermets Composites, C-C Composites
**UNIT 5:**
Ablation & Ablative Materials.

**TEXT BOOKS:**

1. High temperature materials technology – Campbell E.E. and Sherwood – John Wiley and Sons, 1967
2. High temperature technology – Campbell I.E. – John Wiley

**REFERENCE BOOKS:**

1. High temperature materials – Hehmann R.F. – Wiley and sons, 1967.
2. Behaviour of high temperature alloys – Proceeding of International conference, 1979.

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**THERMAL ENGINEERING LABORATORY**

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

10)  Evacuative tube concentrator

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**FUELS, COMBUSTION AND ENVIRONMENT**

**Unit – 1:**
**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 – 2 :**
**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 – 3:**
**Thermodynamics of combustion** – Enthalpy of formation – Heating value of fuel - Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

**Unit – 4 :**
**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 – 5 :**
**Environmental considerations** – Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

**TEXT BOOKS :**
1. Combustion Fundamentals by Roger A strehlow – Mc Graw Hill
2. Fuels and combustion by Sharma and Chander Mohan – Tata Mc Graw Hill

**REFERENCES BOOKS:**

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

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**ENERGY MANAGEMENT**

**UNIT I:**
Introduction: Principles of Energy Management – Managerial Organization – Functional Areas for
i. Manufacturing Industry      ii. Process Industry    iii. Commerce        iv. Government.
Role of Energy Manager in each of these organization.
Initiating, Organising and Managing Energy Management Programs

**UNIT II:**
Energy Audit:  Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques.
Energy Conservation: Technologies for Energy Conservation , Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage – formulation of objectives and constraints – synthesis of alternative options and technical analysis of options – process integration.

**UNIT III:**
Economic Analysis: Scope, Characterization of an Investment Project – Types of Deprecication – Time Value of money – budget considerations, Risk Analysis.


**UNIT IV:**
Methods of Evaluation of Projects : Payback – Annualised Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis.
Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria.

**UNIT V:**
Alternative Energy Sources : Solar Energy – Types of devices for Solar Energy Collection – Thermal Storage System – Control Systems-
Wind Energy – Availability – Wind Devices – Wind Characteristics – Performance of Turbines and systems.

**BOOKS :**
  1. Energy Management Hand book by W.C. Turner (Ed)
  2. Management by H.Koontz and Cyrill O Donnell

**REFERENCES BOOKS:**

1. Financial Management by S.C. Kuchhal
2. Energy Management by W.R.Murthy and G.Mc Kay
3. Energy Management Principles by CB Smith.

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### FINITE ELEMENT ANALYSIS

**UNIT -1:**
Introduction to FEM: basic concepts, historical back ground, application of FEM, general description, comparison of fem with other methods, variational approach, Galerkin 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 -2:**
1-D structural problems – axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape function. Analysis of Trusses – Plane Truss and Space Truss elements. Analysis of beams – Hermite shape functions – stiffness matrix – Load vector – Problems – analysis.

**UNIT -3:**
2-D problems –CST, force terms, Stiffness matrix and load vector, boundary conditions, Isoparametric element – quadrilateral element, Shape functions – Numerical Integration
3-D problems – Tetrahedran element – Jacobian matrix – Stiffness matrix

**UNIT -4:**
Scalar field problems - 1-D Heat conduction – 1-D fin element – 2-D heat conduction problems – Torsion.

**UNIT -5:**
Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen Vector, natural frequencies – mode shapes – modal analysis.

**TEXT BOOKS:**

1. Introduction to finite elements in engineering – Tirupathi K. Chandrupatla and Ashok D. Belagundu.
2. The finite element methods in Engineering – S.S. Rao _ Pergamon, New York

**REFERENCES BOOKS:**

1. An Introduction to Finite Element Methods – J. N. Reddy – Mc Grawhill
2. The Finite element method in engineering science – O.C. Aienkowitz, Mc Grawhill.
3. Concepts and applications of finite element analysis – Robert Cook
4. Finite Element Procedures in Engineering analysis – K.J Bathe

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**COMPUTATIONAL FLUID DYNAMICS**

**UNIT 1:  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 2**: **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 3**: **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 4**: **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 5**: **Turbulent Flows**: Direct Numerical Simulation, Large Eddy Simulation and RANS Models

**Compressible Flows**: Introduction - Pressure, Velocity and Density Coupling.

**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)

**REFERENCE BOOKS:**

1.  An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
2.  Computational Fluid Dynamics – Anderson (TMH)
3.  Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)
4.  Computational Fluid Dynamics, T.J. Chung, Cambridge University
5.  Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier)
6.  Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

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### ELECTIVE III
### EQUIPMENT DESIGN FOR THERMAL SYSTEMS


**Unit - 1: 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, multipass, cross flow heat exchanger design calculations.

**Unit - 2: 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 - 3: Condensation of single vapors:** Calculation of a horizontal condenser, vertical condenser, De-super heater condenser, vertical condenser – sub-cooler, horizontal condenser – subcooler, vertical reflux type condenser, condensation of steam.

**Unit – 4: 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 - 5:  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.


**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.

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**ELECTIVE III**
**CONVECTIVE HEAT TRANSFER**

**Unit-1:Introduction:** 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-2: 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 – 3: 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 – 4: 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 - 5: 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.

**TEXT BOOKS:**
1. Introduction to Convective Heat Transfer Analysis – Patrick H. Oosthuigen & David Naylor (MCH)
2. Convective Heat & Mass Transfer – Kays & Crawford (TMH)

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### ELECTIVE III
### THERMAL AND NUCLEAR POWER PLANTS

**Unit - 1:**
**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 - 2**:
**Gas Turbine Power Plant**: Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages.

**Unit -3:**
**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 -4:**
**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 - 5:**
**Power Plant Instrumentation:** Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution – Types, Methods to Control.

**TEXT BOOKS:**
1.  Power Plant Engineering / P.K. Nag / TMH.

2. Power Plant Engineering / R.K. Rajput / Lakshmi Publications.


**REFERENCE BOOKS:**
3. Power Plant Engineering / P.C.Sharma / Kotaria Publications.
4. Power Plant Technology / Wakil.

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## ELECTIVE IV
## THERMAL MEASUREMENTS AND   PROCESSCONTROLS

**UNIT-1:**
**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-2:**
**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-3:**
**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-4:**
**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-5:**

**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.

**TEXT BOOKS:**

1. Measurement System, Application & Design – E.O. Doeblin.
2. Control Systems, Principles & Design, $2^{nd}$ Edition – M. Gopal – TMH.

**REFERENCE BOOKS:**

1. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
2. Mechanical Measurements – Buck & Beckwith – Pearson.

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### ELECTIVE IV
### REFRIGERATION AND AIR CONDITIONING


**REFRIGERATION :**
**Unit – 1:**
**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 – 2:**
**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 – 3:**
**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 – 4:**
**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 – 5:**
**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.

**TEXT BOOKS :**

1. Refrigeration & Air Conditioning – C.P. Arora(TMH)
2. Refrigeration & Air Conditioning – Arora & Domkundwar  – Dhanpat Rai

**REFERENCE BOOKS :**

1) Refrigeration and Air Conditioning :Manohar Prasad
2) Refrigeration and Air Conditioning : Stoecker – Mc Graw Hill
3) Principles of Refrigeration – Dossat (Pearson)
4) Refrigeration and Air Conditioning : Ananthanarayana (TMH)
5) Refrigeration and Air Conditioning : Jordan and – Prentice Hall, Preister
6) Refrigeration and Air Conditioning : Dossat – Mc Graw Hill
7) Thermal Environmental Engg.      : Threlkeld – Van Nostrand
8) Refrigeration and Air Conditioning : Ballany – Khanna
9) Refrigeration and Air Conditioning : Arora – Tata Mc Graw Hill
10) Refrigeration and Air Conditioning  : Domkundwar – Dhanpatrai
11) Refrigeration and Air Conditioning  : SC Jain S.Chand and Co.
12) Ashrae Hand Book                : 2 Vols.

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**ELECTIVE IV**
**JET PROPULSION AND ROCKETRY**

**Unit - 1:**

**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 - 2:**

**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, $A_c$ / $A_t$ 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 - 3:**

**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 - 4:**

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 - 5: 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.

**TEXT BOOKS:**

1. Mechanics and Dynamics of Propulsion – Hill and Peterson
2. Rocket propulsion elements – Sutton

**REFERENCES BOOKS:**

1. Gas Turbines – Ganesan (TMH)
2. Gas Turbines & Propulsive Systems – Khajuria & Dubey (Dhanpatrai)
3. Rocket propulsion – Bevere
4. Jet propulsion – Nicholas Cumpsty

**MALLA REDDY ENGINEERING COLLEGE (Autonomous)**

**M. Tech. I Year. II Semester**                                    **L   T/P/D**
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**COMPUTATIONAL METHODS LABORATARY**

C programming for problem solving.

Solving Thermal Engineering problems using available packages such as T K Solver,

ANSYS, CFX, STARCD, MATLAB, FLUENT etc…