JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR ANANTAPUR-515002 (A.P) INDIA

ACADEMIC REGULATIONS COURSE STRUCTURE AND DETAILED SYLLABI OF MASTER OF TECHNOLOGY IN THERMAL ENGINEERING

(Regular Two Year P.G. Degree Course (Applicable for the batches admitted from 2012-13)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
Academic Regulations For The Award Of Full Time M.Tech. P.G. Degree
(WITH EFFECT FROM THE ACADEMIC YEAR 2012-13)

The Jawaharlal Nehru Technological University Anantapur shall confer M.Tech. Post Graduate degree to candidates who are admitted to the Master of Technology Programs and fulfill all the requirements for the award of the degree.

1.0 ELIGIBILITY FOR ADMISSIONS:

Admission to the above programme shall be made subject to the eligibility, qualifications and specialization prescribed by the University for each programme, from time to time.

Admissions shall be made either on the basis of merit rank obtained by the qualified candidates at an Entrance Test conducted by the University or on the basis of GATE / PGECET score, subject to reservations prescribed by the University or Government policies from time to time.

2.0 **COURSE WORK:**

2.1 A Candidate after securing admission must pursue the M.Tech. course of study for Four semesters duration.

2.2 Each semester shall be of 20 weeks duration including all examinations.

2.3 A candidate admitted to a programme should complete it within a period equal to twice the prescribed duration of the programme from the date of admission.

3.0 ATTENDANCE:

3.1 A candidate shall be deemed to have eligibility to write end semester examinations if he has put in atleast 75% of attendance on cumulative basis of all subjects/courses in the semester.

3.2 Condonation of shortage of attendance up to 10% i.e., from 65% and above and less than 75% may be given by the college on the recommendation of the Principal.

3.3 Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence.

3.4 If the candidate does not satisfy the attendance requirement he is detained for want of attendance and shall reregister for that semester. He / she shall not be promoted to the next semester.

4.0. 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 practicals, on the basis of Internal Evaluation and End Semester Examination.

4.1 For the theory subjects 60% of the marks will be for the External End Examination. While 40% of the marks will be for Internal Evaluation, based on the better of the marks secured in the two Mid Term-Examinations held, one in the middle of the Semester (I-IV units) and another immediately after the completion of instruction (V-VIII) units with Three questions to be answered out of four in 2hours, evaluated* for 40 marks.

*****Note: All the Questions shall be of equal weightage of 10 marks and the marks obtained for 3questions shall be extrapolated to 40 marks, any fraction rounded off to the next higher mark

4.2 For practical subjects, 60 marks shall be for the End Semester Examinations and 40 marks will be for internal evaluation based on the day to day performance.

4.3 For Seminar there will be an internal evaluation of 50 marks. A candidate has to secure a minimum of 50% to be declared successful. The assessment will be made by a board consisting of HOD and two internal experts at the end of IV semester instruction.

4.4 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.

4.5 In case the candidate does not secure the minimum academic requirement in any of the subjects (as specified in 4.4.) he has to reappear for the Semester Examination either supplementary or regular in that subject, or repeat the course when next offered or do any other specified subject as may be required.

5.0 RE-REGISTRATION FOR IMPROVEMENT OF INTERNAL EVALUATION MARKS:

Following are the conditions to avail the benefit of improvement of internal evaluation marks.

5.1 The candidate should have completed the course work and obtained examinations results for I & II semesters.

5.2 He should have passed all the subjects for which the Internal evaluation marks secured are more than 50%.

5.3 Out of the subjects the candidate has failed in the examination due to Internal evaluation marks secured being less than 50%, the candidate shall be given one chance for each Theory subject and for a maximum of **three** Theory subjects for Improvement of Internal evaluation marks.

5.4 The candidate has to re-register for the chosen subjects and fulfill the academic requirements.

5.5 For each subject, the candidate has to pay a fee equivalent to one third of the semester tuition fee and the amount is to be remitted in the form of D.D. in favour of the

Registrar, JNTUA payable at Anantapur along with the requisition through the Principal of the respective college.

5.6 In the event of availing the Improvement of Internal evaluation marks, the internal evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for the reregistered subjects stand cancelled.

6.0 EVALUATION OF PROJECT WORK:

Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the college/ institute.

6.1 Registration of Project work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses (theory and practical courses of I & II Sem)

6.2 An Internal Departmental Committee (I.D.C) consisting of HOD, Supervisor and one internal senior expert shall monitor the progress of the project work.

6.3 The work on the project shall be initiated in the penultimate semester and continued in the final semester. The duration of the project is for two semesters. The candidate can submit Project thesis with the approval of I.D.C. after 36 weeks from the date of registration at the earliest and one calendar year from the date of registration for the project work. Extension of time within the total permissible limit for completing the programme is to be obtained from the Head of the Institution.

6.4 The student must submit status report at least in three different phases during the project work period. These reports must be approved by the I.D.C before submission of the Project Report.

6.5 A candidate shall be allowed to submit the thesis / dissertation only after passing in all the prescribed subjects (both theory and practical) and then take viva voce examination of the project. The viva-voce examination may be conducted once in two months for all the candidates submitted during that period.

6.6 Three copies of the Thesis / Dissertation certified in the prescribed from by the supervisor & HOD shall be presented to the HOD One copy is to be forwarded to the University and one copy to be sent to the examiner.

6.7 The college shall submit a panel of three experts for a maximum of 5 students at a time. However, the thesis / dissertation will be adjudicated by one examiner nominated by the University.

6.8 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 / dissertation. The board shall jointly report candidates work as:

1.	Very Good	Grade A
2.	Good	Grade B
3.	Satisfactory	Grade C
4.	Not satisfactory	Grade D

If the report of the viva-voce is not satisfactory (Grade D) 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 unless the candidate is permitted to revise and resubmit the thesis.

7.0 AWARD OF DEGREE AND CLASS:

A candidate shall be eligible for the award of respective degree if he satisfies the minimum academic requirements in every subject and secures 'satisfactory' or higher grade report on his thesis/dissertation and viva-voce. Based on overall percentage of marks obtained, the following class is awarded.

First class with Distinction:	70% or more
First class	below 70% but not less than 60%
Second class	below 60% but not less than 50%

8.0 WITH – HOLDING OF RESULTS:

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

9.0 TRANSITORY REGULATIONS:

Candidates who have discontinued or have been detained for want of attendance or who have failed after having undergone the course in earlier regulations and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent subjects as and when subjects are offered, subject to 4.5 and 2.3 sections. Whereas they continue to be in the academic regulations they were first admitted.

10.0 GENERAL:

i. **The academic regulations should be read as a whole for purpose of any interpretation**.
ii. **Disciplinary action for Malpractice / improper conduct in examinations is appended**.
iii. **There shall be no places transfer within the constituent colleges and affiliated colleges of Jawaharlal Nehru Technological University Anantapur.**
iv. **Where the words "he", "him", "his", occur in the regulations, they include "she", "her", "hers".**
v. **In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.**
vi. **The University may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the University.**

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RULES FOR DISCIPLINARY ACTION FOR MALPRACTICE / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.

4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
6.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.

7.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the impostor is an outsider, he will be handed over to the police and a case is registered against him.
8.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the candidates as per the above guidelines.
2. Punishment for institutions : (if the squad reports that the college is also involved in encouraging malpractices)
   (i) A show cause notice shall be issued to the college.
   (ii) Impose a suitable fine on the college.
   (iii) Shifting the examination centre from the college to another college for a specific period of not less than one year.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
Course Structure and syllabi for
M.Tech- Thermal Engineering
Offered by Department of Mechanical Engineering
for affiliated Engineering Colleges 2012-13

I YEAR I Semester

S. No	Course code	Subject	Theory	Lab.	Credits
1.	12D88101	Advanced Thermodynamics	4		4
2.	12D88102	Advanced Heat & Mass Transfer	4		4
3.	12D88103	Turbo Machines	4		4
4.	12D88104	Fuels, Combustion & Environment	4		4
5.	12D88105	FEA in Thermal Engineering	4		4
6.	 12D88106a 12D88106b 12D88106c	Elective-I a. Refrigeration & Air Conditioning b. Equipment design for Thermal Systems c. Optimization Techniques & its Applications	4		4
7.	12D88107	Advanced Thermal Engineering Lab		3	2
		contact periods/week	24	3	
			Total	27	26

I YEAR II Semester

S. No	Course code	Subject	Theory	Lab.	Credits
1.	12D88201	Energy Management	4		4
2.	12D88202	Advanced I.C. Engines	4		4
3.	12D88203	Computational Fluid Dynamics	4		4
4.	12D88204	Thermal Measurements and Process Controls	4		4
5.	12D88205	Alternative Energy Sources	4		4
6.	 12D88206 12D88207 12D88208	Elective-II a. Croyogenics Engineering b. Thermal & Nuclear Power Plants c. Jet Propulsion & Rocketry	4		4
7.	12D88209	Computational Fluid Dynamics Lab		3	2
		contact periods/week	24	3	
			Total 27		26

II YEAR (III & IV Semesters)

S. No	Course code	Subject		credits
1	12D88401	Seminar		2
2	12D88402	Project work		16

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M. Tech. I SEM (TE)	**Th**	**C**
	4	**4**

(12D88101) ADVANCED THERMODYNAMICS

UNIT - I:

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

UNIT - II:

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.

UNIT-III

Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties – Pychrometric properties and psychrometric chart – Air conditioning processes – Cooling Towers – Real Gas mixture.

UNIT – IV:

Combustion – Combustion Reactions – Enthalpy of Formation – Entropy of Formation – Reference Levels for Tables – Energy of formation – Heat of Reaction – Adiabatic flame Temperature- General problems– Enthalpies – Equilibrium.

UNIT-V

Chemical Equilibrium of Ideal Gases – Effects of Non-reacting Gases Equilibrium in Multiple Reactions. The VantHoff's Equation. The chemical potential and phase Equilibrium – The Gibbs phase Rule.

UNIT - VI:

Power cycles, Review; Binary vapour cycle, co-generation and Combined cycles – Second law analysis of cycles – Refrigeration cycles.

UNIT-VII

Thermodynamics of irreversible processes – Introduction – phenomenological laws – Onsagar Reciprocity Relation – Applicability of the phenomenological Relations – Heat Flux and Entropy Production – Thermodynamic phenomenon – Thermo electric circuits.

UNIT - VIII:

Direct Energy Conversion- introduction **–** Fuel Cells – Thermo-electric energy – Thermo-ionic power generation -Thermodynamic devices Magneto Hydrodynamic Generators – Photo voltaic cells.

TEXT BOOKS :

1. Fundamentals of Thermodynamics, Sonntag, Borgnakke and Van Wylen, Wiley, 6th Edition
2. Thermo dynamics, Doolittle, Messe
3. Basic and Applied Thermodynamics, P.K. Nag, TMH

REFERENCE BOOKS :

1. Thermo dynamics, Holman, Mc Graw Hill
2. Irreversible Thermo Dynamics, HR De Groff.
3. Engineering Thermo dynamics,PL.Dhar

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(12D88102) ADVANCED HEAT AND MASS TRANSFER

UNIT- I:
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

UNIT-II
Transient heat conduction; Lumped system analysis- Heisler's charts-semi infinite solid-use of shape factors in conduction - 2D transient heat conduction – problem solutions
Forced Convection: Equations of Fluid Flow – Concepts of Continuity, momentum equations – Derivation of Energy equation – Dimensional Analysis and Similitude

UNIT - III:
External flows: Flow over a flat plate: Critical Reynolds Number - - Methods to determine heat transfer coefficient: Analogy between heat and momentum transfer - Similarity Parameters - Analytical Methods - Exact and Integral methods - Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to various geometries for Laminar and Turbulent flows.

UNIT - IV:
Internal flows: Fully developed flow: Laminar heat transfer coefficient for Constant Wall Temperature and Constant Heat Flux Boundary Conditions - Hydrodynamic and thermal entry lengths; use of empirical correlations. Reylolds – Colburn Analogy - Application of empirical relations to various geometries for Laminar and Turbulent flows.
Free convection: Integral analysis on laminar free convective heat transfer - Different geometries – combined free and forced convection

UNIT - V:
Boiling and condensation: Pool Boiling–Boiling regimes-Correlations. Nusselt's theory of film condensation on a vertical plate – Assumptions and correlations of film condensation for different geometrics.

UNIT-VI

Heat Exchangers: Design - LMTD and NTU methods – Boiler and Condenser – Cross flow and 1 shell 2,4,6,8 pass heat exchangers – Use of charts and empirical correlations

Recent Advancements in Heat transfer applications

UNIT - VII:

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation – radiation from flames.

UNIT-VIII

Mass Transfer: Concepts of mass transfer – Diffusion and convective mass transfer Analogies – Significance of non-dimensional numbers.

TEXT BOOKS :

1. Heat Transfer, Necati Ozisik (TMH)
2. Introduction to Heat Transfer, Frank P. Incropera, David P. Dewitt, Wiley, 4th Edition
3. Heat and Mass Transfer, O P Single (Macmillan India Ltd)

REFERENCE BOOKS :

1. Heat Transfer, P.S. Ghoshdastidar (Oxford Press)
2. Heat Transfer, A basic approach – Yunus Cangel (MH)
3. Heat and 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

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M. Tech. I SEM (TE) **Th** **C**

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(12D88103) TURBO MACHINES

UNIT – I:

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;

UNIT-II

Unsteady flow in turbo machines.

Steam Nozzles: Convergent and Convergent – Divergent nozzles; Energy balance; effect of backpressure on the analysis;

UNIT-III

Steam Turbines : Types; work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height;

UNIT – IV:

Gas Dynamics: Fundamentals: Tthermodynamic 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.

UNIT-V

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; pre-whirl; performance.

UNIT – VI:

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 – VII:

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;

UNIT-VIII

Stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

TEXT BOOKS:

1. Fundamentals of Turbo machines , Shephard
2. Practise on Turbomachines , G. Gopalakrishnan & D. Prithviraj, SciTech Publishers, Chennai.
3. Elements of Gas Dynamics , Yahya

REFERENCE BOOKS :

1. Gas Turbines , Theory and practice , Zucrow
2. Turbines, Pumps, Compressors , Yahya
3. Axial Flow Compressors , Horlock.
4. Gas Turbines- Cohen, Roger & Sarvanamuttu

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M. Tech. I SEM (TE)	**Th**	**C**
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(12D88104) FUELS, COMBUSTION AND ENVIRONMENT

UNIT – I:

Fuels – Detailed classification– Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal.

UNIT-II

Coal – Carbonization, Gasification and liquification – Types of coals-Lignite, Anthracite, Bituminous, Peat : petroleum based fuels – problems associated with very low calorific value gases; Coal Gas – Blast Furnace Gas, Alcohols and Biogas.

UNIT – III:

Principles of combustion– Chemical composition – Flue gas anlaysis – dew point of products – Combustion stoichiometry.

UNIT-IV

Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroeth, First, Second and Third order reactions - complex reactions – chain reactions. Theories of reaction- Kinetics – General oxidation behavior of HC's.

UNIT – V:

Thermodynamics of combustion– Enthalpy of formation – Heating value of fuel - Adiabatic flame Temperature – Equilibrium composition of gaseous mixtures.

Unit – VI:

Laminar and turbulent flames propagation and structure– Flame stability – Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity.

UNIT-VII

Combustion of fuel, droplets and sprays – Combustion systems – Pulverised fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

UNIT – VIII :

Environmental considerations – Automobile Emissions - Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

TEXT BOOKS :

1. Combustion Fundamentals , Roger A, Strehlow, Mc Graw Hill
2. Fuels and combustion , Sharma and Chander Mohan, Tata Mc Graw Hill
3. Combustion Engineering and Fuel Technology , Shaha A.K., Oxford and IBH.

REFERENCE BOOKS:

1. Principles of Combustion , Kanneth K.Kuo, Wiley and Sons.
2. Combustion , Sarkar, Mc. Graw Hill.
3. An Introduction to Combustion, Stephen R. Turns, Mc. Graw Hill International Edition.
4. Combustion Engineering, Gary L. Berman & Kenneth W. Ragland, Mc. Graw Hill International Edition.
5. Combustion, I. Glassman

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M. Tech. I SEM (TE)	**Th**	**C**
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(12D88105) FINITE ELEMENT ANALYSIS IN THERMAL ENGINEERING

UNIT - I:

Introduction to FEM: basic concepts, application of FEM, general description, advantages of FEM, comparison of FEM with other methods : finite difference method, variational method, Galerkin Method, basic element shapes, interpolation function. Virtual energy principle, treatment of boundary conditions, solution of system of equations,basic equations of elasticity, strain displacement relations.

UNIT - II:

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.

UNIT-III

Analysis of beams, frames – Hermite shape functions, stiffness matrix, load vector problems, analysis.

UNIT - IV:

2-D problems – CST, force terms, stiffness matrix and load vector, boundary conditions, Iso-parametric element, Quadric element, shape functions, Numerical Integration, 3-D problems – Tetrahedron element, Jacobian matrix, stiffness matrix.

UNIT - V :

Axis Symmetric formulations, Finite Element Modeling- Triangular element, Problem modeling and Boundary conditions

UNIT - VI :

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

UNIT - VII:

Scalar field problems – Generalized Heat Conduction Equation – Variation Principle – Boundary Conditions – Internal heat generation, heat flux and convection - 1-D Steady state Heat conduction – Thermal load vector - 1-D fin element – Quadratic fin elements

I D unsteady state heat conduction – Thermal load vector - 2-D steady state heat conduction – Concepts of 3D heat conduction
Finite Element Formulation of Torsion, Potential flow, seepage and fluid flow in ducts.

UNIT-VIII

Computer Implementation : Pre-processing , mesh generation, elements connecting, boundary conditions, input of material and processing characteristics – solutions and post processing- overview and application packages

TEXT BOOKS :

1. Finite Element Methods, Alavala, PHI
2. Introduction to finite elements in engineering , Tirupathi K. Chandrapatla and Ashok D. Belagundu.

REFERENCE BOOKS :

1. An Introduction to Finite Element Methods, S.S. Rao , Pegamon, New York.
2. The Finite element method in Engineering science, O.C. Aienkowitz, Mc. Graw Hill.
3. Concepts and applications of finite element analysis, Robert Cook.
4. Finite Element Methods in Engineering analysis, K.J. Bathe.
5. The finite element method in Heat transfer analysis- Lewis R.W, Morgan.K, Thomas H.R. and Seetharaman K.N, John Wiley, 1994

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M. Tech. I SEM (TE) **Th** **C**

4 **4**

(12D88106a) REFRIGERATION AND AIR CONDITIONING (ELECTIVE I)

UNIT – I:

Vapour Compression Refrigeration : Analysis and Performance of Complete vapour compression Refrigeration system. Components of Vapour Compression Refrigeration System**:** The condensing unit – Evaporators – Expansion valve ; Refrigerants – Properties – ODP and GWP.

UNIT-II

Compound Compression: Need; Compounding with external intercooling, Flash mixing Flash inter-cooling – liquid flash internal cooling – Multi Pressure-(Multistage)systems. Cascade System – Applications

UNIT – III:

Vapor absorption Refrigeration system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram.
Lithium – Bromide system Three fluid system – HCOP.

UNIT – IV:

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 systems: working principles of Thermo-electric Refrigeration – Vortex tube.

UNIT – V:

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.

UNIT-VI

Cooling load Estimation: Occupants, equipments, heat gain due to- infiltration, fan load, Fresh air load (Ventilation). Summer , Winter and year round air – conditioning systems.

UNIT – VII:

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.

UNIT-VIII

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 and Air Conditioning, C.P. Arora(TMH)
2. Refrigeration and Air Conditioning, Manohar Prasad
3. Refrigeration and Air Conditioning, Stoecker , Mc Graw Hill

REFERENCE BOOKS :

1. Principles of Refrigeration, Dossat (Pearson)
2. Refrigeration and Air Conditioning, Arora & Domkundwar , Dhanpat Rai
3. Refrigeration and Air Conditioning, Ananthanarayana (TMH)
4. Refrigeration and Air Conditioning, Jordan and , Prentice Hall, Preister
5 Ashrae Hand Book

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4 **4**

(12D88106b) EQUIPMENT DESIGN FOR THERMAL SYSTEMS (ELECTIVE I)

UNIT - I:

Classification of heat exchangers: Introduction, Recuperation and Regeneration – Tubular heat exchangers: double pipe, shell and 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 Exchangers: 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 - 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.

UNIT - III

Shell and 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 and tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

UNIT - IV:

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

UNIT –V:

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

UNIT - VI

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 - VII:

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb and dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance

UNIT - VIII

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, J.D. Gurney
3. Heat Exchanger Design, A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York.

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4 **4**

(12D88106c) OPTIMIZATION TECHNIQUES AND ITS APPLICATIONS (ELECTIVE I)

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UNIT- I*:*

Introduction: Engineering Applications of optimization- statement of an optimization problem – Classification of optimization problems.

UNIT-II

Single Variable Non-Linear Unconstrained Optimization: One dimensional Optimization methods:- Uni-modal function, elimination methods, Fibonacci method, golden section method, interpolation methods – quadratic and cubic interpolation methods.

UNIT- III:

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- IV:

Linear Programming – Graphical method-Simplex method- Dual simplex method- Revised simplex method- Parametric linear programming- Goal Programming
Simulation- types of simulations- Applications of simulations to inventory, queuing and thermal systems.

UNIT- V:

Integer Programming- Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method

UNIT-VI

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

UNIT- VII:

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

UNIT- VIII

Non Traditional Optimization Algorithms: Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm and Traditional Methods. Simulated Annealing- Working Principle-Simple Problems. Application in production problems.

TEXT BOOKS:

1. Optimization theory and Applications,S.S.Rao,New Age International.
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI

REFERENCE BOOKS:

1. Operations Research, S.D.Sharma,
2. Operation Research, H.A.Taha ,TMH
3. Optimization in operations research, R.LRardin
4. Optimization Techniques, Belagundu & Chandraputla, Pearson Asia.
5. Optimization Techniques theory and practice, M.C.Joshi, K.M.Moudgalya, Narosa Publications

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3 **2**

(12D88107) ADVANCED 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 rig.
7. Performance analysis of Air conditioning unit.
8. Performance analysis of heat pipe.
9. Solar Flat Plate Collector Performance
10. Evacuative tube concentrator Performance
11. Calibration of temperature measurement apparatus.

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4 **4**

(12D88201) ENERGY MANAGEMENT

UNIT - I:

Introduction: Principles of Energy Management – Managerial Objectives –Energy Management in Functional Areas like Manufacturing Industry, Process Industry, Commerce -Government- Role of Energy Manager in each of these organization.

UNIT-II

Initiating, Organising and Managing, Energy Management Programs

UNIT - III:

Energy Audit: Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques.

UNIT-IV

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 - V:

Economic Analysis: Scope, Characterization of an Investment Project – Types of Depreciation – Time Value of money – budget considerations, Risk Analysis.

UNIT - VI:

Methods of Evaluation of Projects: Payback – Annualized Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis.

UNIT-VII:

Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria-Energy Regulatories- Institutions.

UNIT - VIII:

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.

TEXT BOOKS :

1. Energy Management Hand book, W.C. Turner (Ed)
2. Management, H.Koontz and Cyrill O Donnell
3. Financial Management, S.C. Kuchhal
4. Financial Management, I M Panday

REFERENCE BOOKS:

1. Energy Management, W.R.Murphy and G.Mc Kay
2. Energy Management Principles, CB Smith.

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4 **4**

(12D88202) ADVANCED I.C. ENGINES

UNIT - I:
Introduction – Historical Review – Engine Types – Design and operating Parameters.
Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties

UNIT-II
Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

UNIT - III:
Gas Exchange Processes: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.

UNIT-IV
Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

UNIT - V:
Combustion in S.I engines: Combustion and Speed – Cyclic Variations – Ignition – Abnormal combustion Fuel factors, MPFI, SI engine testing.
Pollutant Formation and Control: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate

UNIT-VI
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 - VI:
Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

UNIT - VII:
Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.

UNIT-VIII

SI and CI Engine Simulation and 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. Computer Simulation of Compression Ignition Engine Processes, V. Ganesan, Universities Press
3. Computer Simulation of Spark Ignition Engine Processes, V. Ganesan, Universities Press

REFERENCES BOOKS:

1. The I.C. Engine in theory and Practice Vol.I, And Vol.II, Teylor, IIT Prof.
2. I.C. Engines, Obert,Int , Text Book Co.
3. Combustion Engine Processes, Lichty
4. I.C. Engines, Ferguson
5. Scavenging of Two stroke Cycle Engines , Switzer.

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(12D88203) COMPUTATIONAL FLUID DYNAMICS

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

UNIT-III:
Extension of General Nodal Equation to 2D and 3D Steady heat conduction and Unsteady heat conduction

UNIT -IV:

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

UNIT - VII:

Turbulent Flows: Direct Numerical Simulation, Large Eddy Simulation and RANS Models

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

TEXT BOOKS:

1. Numerical heat transfer and fluid flow, S.V. Patankar (Hemisphere Pub. House)
2. An Introduction to Computational Fluid Dynamics, FVM Method , H.K. Versteeg, W. Malalasekhara (PHI)
3. Computational Fluid Flow and Heat Transfer , Muralidharan & Sundararajan (Narosa Pub)

REFERENCE BOOKS:

1. Computational Fluid Dynamics, Hoffman and Chiang, Engg Education System
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. Computational Fluid Dynamics, A Practical Approach, Tu, Yeoh, Liu (Elsevier)
6. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

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4 **4**

(12D88204) THERMAL MEASUREMENTS AND PROCESS CONTROLS

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.

UNIT-II

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-III:

Measurement of Flow: Obstruction meters, variable area meters. Pressure probes and their classification and applications

UNIT-IV

compressible fluid flow measurement, Thermal anemometers, calibration of flow measuring instruments. Introduction to design of flow measuring instruments.

UNIT-V:

Temperature Measurement: Different principles of Temperature Measurement, use of bimetallic thermometers – Mercury thermometers, Vapor Pressure thermometers

UNIT-VI

Thermo positive elements, thermocouples in series and parallel, pyrometry, measurement of heat flux, calibration of temperature measuring instruments. Design of temperature measuring instruments.

UNIT-VII:

Level Measurement: Direct and 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.

UNIT-VIII

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-VIII:

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 and 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 and 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 and Design, 2nd Edition , M. Gopal , TMH.

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4 **4**

(12D88205) ALTERNATIVE ENERGY SOURCES

UNIT-I

Solar Energy : Solar Radiation – Capturing Solar Radiation- Types of Collectors – Concentric Solar Power (CSP)- Applications.

UNIT-II

Wind Energy: Wind Energy Characteristics – Site Location Factors –Wind Energy Conversion Systems – Betz Model-Applications

UNIT-III

Geothermal Energy : Availability of Geothermal Energy-size and Distribution , Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy , Direct heat applications , Power Generation using Geothermal Heat, Sustainability of Geothermal Sources, Status of Geothermal Technology , Economics of Geothermal Energy.

UNIT-IV

Tidal and Wave Energy –Performance Limits- Ocean Thermal Energy Conversion (OTEC Technology)

Unit-V

Hydrogen Energy-Hydrogen as a renewable energy source, Hydrogen Fuel for Vehicles.
Hydrogen Production : Direct electrolysis of water , thermal decomposition of water , biological and bio chemical methods of hydrogen production
Storage of Hydrogen : Gaseous , Cryogenic and Metal hydride.

Unit VI

Fuel Cell- Principle of working various types of fuel cells , construction and applications , limitations

Unit VII

Hydro power: Potential , Hydropower Generation and Distribution, Mini and Microhydel Power(MHP) Generation : Classification of Hydel plants , Concept of micro Hydel, merits, MHP plants: Components , design and layout, Turbines , efficiency, Status in India.

Unit VIII

Nuclear Energy

Potential of Nuclear Energy , International Nuclear Policies and Regulations. Nuclear Energy Technologies – Fuel enrichment , Different types of Nuclear Reactors , Nuclear Waste Disposal and Nuclear Fusion

Reference Books:

1.Renewable Sources of Energy and Conversion Systems, N.K.Bansal and M.K Kleeman
2.Principles of Thermal Process, Duffie, Beckman
3.Solar Energy Handbook, Kreith and Kreider (McGrawHill)
4.Suitable Energy , Choosing Among Options,Jefferson
5.Renewable Energy Sources, John Twidell & Tony Weir, Taylor & Francis
6.Hydrogen Technology for Energy, D.A.Maths (Noyes Data Corp.)
7.Handbook, Batteries and Fuel cell, Linden (MC. Graw Gill)
8.Batteries Volume (I) and (II), Collins.

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(12D88206) CRYOGENIC ENGINEERING (ELECTIVE II)

Unit-I
Introduction necessity of low temperature - Multistage Refrigeration system -Cascade system - Manufacture of dry ice-Joule Thompson coefficient.

Unit-II.
Liquification of air - Linde system- Analysis- Dual pressure cycle analysis-Liquefaction of Hydrogen and Helium-problems.

Unit-III.
Application of Lower temperatures- Effects on the properties of metals-strength-Thermal properties-super conductivity-super fluidity.

Unit-IV.
Applications like expansion fitting - cryobiology-cryosurgery - space research-computers under ground power lines.

Unit- V.
Low temperature insulation- Reflective insulation-Evacuated powders-Rigid foams-Super insulation.

Unit-VI & VII.
Cooling by adiabatic de-magnetization - Gas separation and cryogenic systems-separation of gases- Rectifying columns-Air separating- single and double columns Air separation plant.

Unit-VIII.
Storage and handling of cryogenic liquids - Dewars and other types of containers.

TEXT BOOKS:
1. Cryogenic Systems, R.F. Barron, Oxford University Press

2. Cryogenic Research and Applications, Marshall Sitting, Von Nostrand Inc, New Jersey
3. Cryogenics Engineering Edit by B.A.Hands, Academic Press, 1986

REFERENCE BOOKS:

1. Cryogenics Engineering, R. B. Scott, Von Nostrand Inc, New Jersey, 1959
2. Cryogenics process Engineering, K.D.Timmerhaus & TM Flynn, Plenum press, 1998
3. Cryogenic Engineering – Thomas M. Flynn
4. Safety in Handling of Cryogenic Fluids, Fredrick J. Edeskutty and Watter F. Stewart, Plenum Press, 1996
5. Hand Book of Cryogenic Engineering, J.G.Weisend–II, Taylor and Francis, 1998
6. Refrigeration and Air-conditioning, S.Domkundwar.

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(12D88207) THERMAL AND NUCLEAR POWER PLANTS

(ELECTIVE II)

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.

Unit - II:

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.

Unit - III:

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

Unit - IV:

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

Unit -V:

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

Unit -VI:

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 -VII:

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 - VIII:

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

TEXT BOOKS:

1. Power Plant Technology, El Wakil.
2. Power Plant Engineering, P.C.Sharma, Kotaria Publications.
3. Power Plant Engineering, P.K. Nag, TMH.

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4 **4**

(12D88208) JET PROPULSION AND ROCKETRY (ELECTIVE II)

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 propulsion, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

UNIT-III

Nozzle: Theory and Characteristics and 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 - IV:

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.

UNIT-V

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 - VI:

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.

UNIT-VII

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 - VIII:

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 and Propulsive Systems, Khajuria & Dubey (Dhanpatrai)
3. Rocket propulsion, Bevere
4. Jet propulsion, Nicholas Cumpsty

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3 **2**

(12D88209) COMPUTATIONAL FLUID DYNAMICS LAB

1. Simulation of Plane Poiseuille flow through long Parallel and Stationary Plates and Plotting Velocity Contours and Velocity Variation along the horizontal central line . Take the distance between the plates as 4 cm. Properties of fluid are v=0.000217 m^2/s p=800 kg/m^2
2. Simulation of Couette flow when the upper plates is moving with a velocity of 40 m/s. Take the distance between the plates as 4 cm properties of fluid are v=0.000217 m^2/s, p=800 kg/m^3 . Make simulations for a pressure gradient of 0-30000 $N/m^2/m$ and 20000 N m^2/m and report the variation of velocity contours for each case.
3. Simulation of a channel flow (Tube flow) for a tube of diameter. 5 cm and take the fluid as water at 30^0C at the entry of the tube of length 0.7m. A heat flux of 3000 W/m^2 is imposed along a wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
4. Simulation of a channel flow (Tube flow) for a tube of diameter 5 cm and take the fluid as water at 30^0C at the entry of the tube length 0.7m . A Constant wall temperature of 300^0C is imposed along the wall. Obtain the contours of Velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.
5. Unsteady simulation of compressible flow of air through 2D a convergent – Divergent nozzle, with inlet and outlet of 0.2m size and both are joined by a throat section where the flow area is reduced by 10% and is of sinusoidal shape. Air enters the nozzle at a pressure of 0.9 bar and leaves at 0.73 bar. Obtain the contours of velocity, pressure and Mach number.
6. Simulation of flow over a circular cylinder of size 5 cm for different Reynold's number values of air and plotting the contours of velocity and vorticity
7. Simulation of temperature counters for a square plate of size 0.2m subjected to different types of boundary conditions.
8. Simulation of temperature counters for a pin fin in natural and forced convective conditions