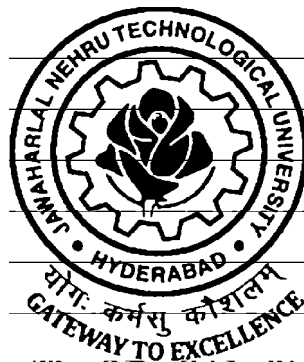


**ACADEMIC REGULATIONS  
COURSE STRUCTURE  
AND  
DETAILED SYLLABUS**

**M.TECH  
THERMAL ENGINEERING**

(Applicable for the batches admitted from 2013-14)



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD  
KUKATPALLY, HYDERABAD – 500 085.**



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**ACADEMIC REGULATIONS R13 FOR M. TECH. (REGULAR) DEGREE COURSE****Applicable for the students of M. Tech. (Regular) Course from the Academic Year 2013-14 and onwards**

The M. Tech. Degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the Degree.

**1.0 ELIGIBILITY FOR ADMISSIONS**

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University or on the basis of any other order of merit as approved by the University, subject to reservations as laid down by the Govt. 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 in not less than two and not more than four academic years. However, he is permitted to write the examinations for two more years after four academic years of course work.
- 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 student shall register for all 88 credits and secure all the 88 credits.
- 2.4 The minimum instruction days in each semester are 90.

**3.0 A. COURSES OF STUDY**

The following specializations are offered at present for the M. Tech. course of study.

1. Advanced Manufacturing Systems
2. Aerospace Engineering/ Aeronautical Engineering
3. Automation
4. Biomedical Signal Processing and Instrumentation
5. Bio-Technology
6. CAD/CAM
7. Chemical Engineering
8. Communication Systems
9. Computer Networks
10. Computer Networks and Information Security
11. Computer Science
12. Computer Science and Engineering
13. Computers and Communication Engineering.
14. Construction Management
15. Control Engineering
16. Control Systems
17. Cyber Forensic / Cyber Security & Information Technology
18. Design for Manufacturing/ Design and Manufacturing
19. Digital Electronics and Communication Engineering.
20. Digital Electronics and Communication Systems
21. Digital Systems and Computer Electronics
22. Electrical Power Engineering
23. Electrical Power Systems
24. Electronics & Instrumentation

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25. Electronics and Communication Engineering
  26. Embedded Systems
  27. Embedded Systems and VLSI Design
  28. Energy Systems
  29. Engineering Design
  30. Environmental Engineering
  31. Geoinformatics and Surveying Technology
  32. Geotechnical Engineering.
  33. Heating Ventilation & Air Conditioning.
  34. Highway Engineering
  35. Image Processing
  36. Industrial Engineering and Management
  37. Information Technology
  38. Infrastructure Engineering
  39. Machine Design
  40. Mechatronics.
  41. Microwave & Radar Engineering
  42. Nano Technology
  43. Neural Networks
  44. Parallel Computing
  45. Power and Industrial Drives
  46. Power Electronics
  47. Power Electronics and Electrical Drives
  48. Power Engineering and Energy Systems
  49. Power Plant Engineering & Energy Management
  50. Power System Control and Automation
  51. Power System with Emphasis H.V. Engineering / H.V. Engineering
  52. Production Engineering.
  53. Real Time Systems
  54. Software Engineering
  55. Structural Engineering
  56. Systems & Signal Processing
  57. Thermal Engineering.
  58. Transportation Engineering
  59. VLSI
  60. VLSI and Embedded System/ Electronics Design Technology
  61. VLSI Design
  62. VLSI System Design
  63. Web Technologies
  64. Wireless and Mobile Communication

and any other course as approved by the University from time to time.

**3.0 B. Departments offering M. Tech. Programmes with specializations are noted below:**

<b>Civil Engg.</b>	Construction Management Environmental Engineering Geoinformatics and Surveying Technology Geotechnical Engineering Highway Engineering Infrastructure Engineering Structural Engineering Transportation Engineering
<b>EEE</b>	Control Engineering Control Systems Electrical Power Engineering Electrical Power Systems Power and Industrial Drives Power Electronics Power Electronics and Electrical Drives Power Engineering and Energy Systems Power Plant Engineering & Energy Management Power System Control and Automation Power System with Emphasis H.V. Engineering / H.V. Engineering
<b>ME</b>	Advanced Manufacturing Systems Automation CAD/CAM Design for Manufacturing/ Design and Manufacturing Energy Systems Engineering Design Heating Ventilation & Air Conditioning Industrial Engineering and Management Machine Design Mechatronics. Power Plant Engineering & Energy Management Production Engineering Thermal Engineering.
<b>ECE</b>	Biomedical Signal Processing and Instrumentation Communication Systems Computers and Communication Engineering. Digital Electronics and Communication Engineering. Digital Electronics and Communication Systems Digital Systems and Computer Electronics Electronics & Instrumentation Electronics and Communication Engineering Embedded Systems Embedded Systems and VLSI Design

	Microwave & Radar Engineering Systems & Signal Processing VLSI VLSI and Embedded System/ Electronics Design Technology VLSI Design VLSI System Design Wireless and Mobile Communication
<b>CSE</b>	Computer Networks Computer Networks and Information Security Computer Science Computer Science and Engineering Cyber Forensic / Cyber Security & Information Technology Image Processing Information Technology Neural Networks Parallel Computing Real Time Systems Software Engineering Web Technologies
<b>Aeronautical Engg.</b>	Aerospace Engineering / Aeronautical Engineering
<b>Bio-technology</b>	Bio-Technology
<b>Chemical Engg.</b>	Chemical Engineering
<b>Nano Technology</b>	Nano Technology

#### 4.0 ATTENDANCE

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

- 4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.
- 4.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee.
- 4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.
- 4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class and their registration shall stand cancelled.
- 4.5 A prescribed fee shall be payable towards condonation of shortage of attendance.
- 4.6 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.
- 4.7 A candidate shall put in a 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.
- 4.8 A student shall not be promoted to the next semester unless he satisfies the attendance requirements of the previous semester including the days of attendance in sports, games, NCC and NSS activities.

## 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 practicals, 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 and 40 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the average 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 mid term examination shall be conducted for a total duration of 120 minutes with Part A as compulsory question (16 marks) which consists of four sub-questions and carries 4 marks each and Part B with 3 questions to be answered out of 5 questions each question for 8 marks. If any candidate is absent from any subject of a mid-term examination, an on-line test will be conducted for him by the University. The details of the Question Paper pattern for End Examination (Theory) is given below:
- The End semesters Examination will be conducted for 60 marks which consists of two parts viz. i).Part-A for 20 marks, ii). Part –B for 40 marks.
  - Part-A is compulsory question where it consists of five questions one from each unit and carries four marks each. This will be treated as Question 1.
  - Part-B consists of five Questions (numbered from 2 to 6) carries 8 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an “either” “or” choice (that means there will be two questions from each unit and the student should answer only one question)
- 5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations and 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 semester. 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 Academic Committee consisting 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% of marks 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 of the Department. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects he has studied during the M. Tech. course of study. The Comprehensive Viva-Voce is evaluated 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 semester 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 5.5) he has to reappear for the End semester 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 so has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled.
- 5.7 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the End Examination in that subject. 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 the Laboratory Class Teacher and the second examiner shall be another Laboratory Teacher.

#### 6.0 EVALUATION OF PROJECT/DISSERTATION WORK

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

- 6.1 A Project Review Committee (PRC) shall be constituted with Principal as Chairperson, Heads of all the Departments 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, both theory and practical.

- 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 Academic Committee for approval. Only after obtaining the approval of the Departmental Academic Committee can the student initiate the Project work.

- 6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Departmental Academic Committee. However, the Departmental Academic Committee shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, 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 A candidate shall submit his 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 at the beginning of the II year and the duration of the project is 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 make an oral presentation 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 University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

- 6.9 If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected.

- 6.10 If the report of the examiner is favourable, 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 the candidate's work as one of the following:

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

The 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 shall retake the Viva-Voce examination only 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:

<b>Class Awarded</b>	<b>% of marks to be secured</b>
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 memorandum of marks.

**8.0 WITHHOLDING OF RESULTS**

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester. His degree will be withheld in such cases.

**9.0 TRANSITORY REGULATIONS**

- 9.1 Discontinued, detained, or failed candidates are eligible for admission to two earlier or equivalent subjects at a time as and when offered.
- 9.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per R13 academic regulations.

**10. GENERAL**

- 10.1 Wherever the words "he", "him", "his", occur in the regulations, they include "she", "her", "hers".
- 10.2 The academic regulation should be read as a whole for the purpose of any interpretation.
- 10.3 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.
- 10.4 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

## MALPRACTICES RULES

## DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	<i>If the candidate:</i>	
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.	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 imposter is an outsider, he will be handed over to the police and a case is registered against him.

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.	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.
6.	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.
7.	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.

8.	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.
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.	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.
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 HYDERABAD

**M.TECH - THERMAL ENGINEERING**  
**COURSE STRUCTURE AND SYLLABUS**

**I Year I Semester**

Code	Group	Subject	L	P	Credits
		Advanced Optimization Techniques & Applications	3	-	3
		Advanced Thermodynamics	3	-	3
		Advanced Heat & Mass Transfer	3	-	3
		Advanced Fluid Mechanics	3	-	3
	Elective – I	Turbo-Machines Cryogenics Engineering Solar Energy Technology	3	-	3
	Elective–II	Advanced I.C. Engines Non-conventional Energy Sources Material Science	3	-	3
	Lab	Thermal Engineering Lab	-	3	2
		Seminar	-	-	2
		<b>Total Credits</b>	18	<b>3</b>	<b>22</b>

**I Year II Semester**

Code	Group	Subject	L	P	Credits
		Fuels, Combustion & Environment	3	-	3
		Energy Management	3	-	3
		Advanced Finite Element Analysis	3	-	3
		Computational Fluid Dynamics	3	-	3
	Elective–III	Equipment Design for Thermal Systems Convective Heat Transfer Thermal & Nuclear Power Plants	3	-	3
	Elective–IV	Thermal Measurements and Process controls Refrigeration & Air-Conditioning Jet Propulsion & Rocketry	3	-	3
	Lab	Computational Methods Lab	-	3	2
		Seminar	-	-	2
		<b>Total Credits</b>	18	<b>3</b>	<b>22</b>

**II Year - I Semester**

Code	Group	Subject	L	P	Credits
		Comprehensive Viva	-	-	2
		Project Seminar	-	3	2
		Project work	-	-	18
		<b>Total Credits</b>	-	<b>3</b>	<b>22</b>

**II Year - II Semester**

Code	Group	Subject	L	P	Credits
		Project work and Seminar	-	-	22
		<b>Total Credits</b>	-	-	<b>22</b>

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

## ADVANCED OPTIMIZATION TECHNIQUES AND APPLICATIONS

## UNIT-I

**Single Variable Non-linear Unconstrained Optimization:** One dimensional Optimization methods, Unimodal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

## UNIT - II

**Multi Variable Non-linear Unconstrained Optimization:** Direct search method – Univariate 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 - III

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

**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 – Sensitivity 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.

## REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International.
2. Introductory to operation research/Kasan & Kumar/Springer.
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH.
5. Optimization in operations research/R.L Rardin.
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia.
7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

## ADVANCED THERMODYNAMICS

## UNIT -I:

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

## UNIT-II:

**P.V.T Surface:** Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius, Clapeyro equation. Throttling, Joule. Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

## UNIT-III:

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

## UNIT-IV:

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

## UNIT-V:

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

## REFERENCES:

1. Basic and Applied Thermodynamics/ P.K.Nag/ TMH.
2. Thermodynamics/Holman/ Me Graw Hill.
3. Engg. Thermodynamics/PL.Dhar / Elsevier.
4. Thermodynamics/Sonnatag & Van Wylen / John Wiley & Sons.
5. Thermodynamics for Engineers/Doolittle-Messe / John Wiley & Sons.
6. Irreversible thermodynamics/HR De Groff.
7. Thermal Engineering / Soman / PHI.
8. Thermal Engineering / Rathore / TMH.
9. Engineering Thermodynamics/Chatopadyaya.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

## ADVANCED HEAT AND MASS TRANSFER

## UNIT-I:

**Brief Introduction to Different Modes of Heat Transfer:** Conduction: General heat Conduction equation-initial and boundary conditions.

**Transient Heat Conduction:** Lumped system analysis-Heisler charts-semi infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions.

## UNIT- II:

**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-III:

**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 geometries 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-IV:

**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-Nusselts theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

## UNIT-V:

**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.

## REFERENCES:

1. Principals of Heat Transfer/Frank Kreith/Cengage Learning.
2. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012.
3. Heat Transfer/RK Rajput/S.Chand.
4. Introduction to Heat Transfer/SK Som/PHI.
5. Engineering Heat & Mass Transfer/Mahesh Rathore/Lakshmi Publications.
6. Heat Transfer / Necati Ozisik / TMH.
7. Heat Transfer / Nellis & Klein / Cambridge University Press / 2012.
8. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press.
9. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai.
10. Heat Transfer/ P.K.Nag/TMH.



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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**
**I Year -I Sem. M.Tech (Thermal Engg.)**
**ADVANCED FLUID MECHANICS**
**UNIT I:**

**Inviscid Flow of Incompressible Fluids:** Lagrangian and Eulerian Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions.

**Basic Laws of fluid Flow:** Condition for irrotationality, circulation & vorticity Accelerations in Cartesian systems normal and tangential accelerations, Euler's, Bernoulli equations in 3D– Continuity and Momentum Equations

**UNIT II:**

**Viscous Flow:** Derivation of Navier-Stokes Equations for viscous compressible flow – Exact solutions to certain simple cases : Plain Poiseuille flow - Couette flow with and without pressure gradient - Hagen Poiseuille flow - Blasius solution.

**UNIT III:**

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

**UNIT IV:**

**Introduction to Turbulent Flow:** Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations - Prandtl Mixing Length Model - Universal Velocity Distribution Law: Van Driest Model – Approximate solutions for drag coefficients – More Refined Turbulence Models – k-epsilon model - boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders

**Internal Flow:** Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

**UNIT V:**

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

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

**REFERENCES:**

1. Fluid Mechanics and Machines/Modi and Seth/Standard Book House.
2. Fluid Mechanics/Cohen and Kundu/Elsevier/5<sup>th</sup> edition.
3. Fluid Mechanics/Potter/Cengage Learning.
4. Fluid Mechanics/William S Janna/CRC Press.
5. Fluid Mechanics and Machines/CP Kodandaraman/New Age Publications.
6. A Text book of Fluid Mechanics/RK Rajput/S. Chand.
7. Boundary Layer Theory/ Schlichting H /Springer Publications.
8. Dynamics & Theory and Dynamics of Compressible Fluid Flow/ Shapiro.
9. Fluid Mechanics and Machinery/ D. Rama Durgaiyah/New Age Publications.
10. Fluid Dynamics/ William F. Hughes & John A. Brighton/TMH.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

**TURBO MACHINES  
(ELECTIVE-I)****UNIT-I:**

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

**UNIT -II:**

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

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

**UNIT-III:**

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

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

**UNIT-IV:**

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

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

**UNIT-V:**

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

**REFERENCES:**

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

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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD****I Year -I Sem. M.Tech (Thermal Engg.)****CRYOGENIC ENGINEERING  
(ELECTIVE-I)****UNIT -I:**

**Introduction to Cryogenic Systems:** Mechanical Properties at low temperatures. Properties of Cryogenic Fluids.

**Gas Liquefaction:** Minimum work for liquefaction. Methods to protect low temperature. Liquefaction systems for gases other than Neon. Hydrogen and Helium.

**UNIT II:**

**Liquefaction Systems for Neon, Hydrogen and Helium:** Components of Liquefaction systems. Heat exchangers. Compressors and expanders. Expansion valve, Losses in real machines.

**UNIT-III:**

**Gas Separation and Purification Systems:** Properties of mixtures, Principles of mixtures, Principles of gas separation, Air separation systems.

**UNIT-IV:**

**Cryogenic Refrigeration Systems:** Working Medium, Solids, Liquids, Gases, Cryogenic fluid storage & transfer, Cryogenic storage systems, Insulation, Fluid transfer mechanisms, Cryostat, Cryo Coolers

**UNIT-V:**

**Applications:** Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

**REFERENCES:**

1. Cryogenic Systems/ R.F.Barren/ Oxford University Press.
2. Cryogenic Research and Applications: Marshal Sitting/ Von Nostrand/ Inc. New Jersey.
3. Cryogenic Heat Transfer/ R.F.Baron.
4. Cryogenic Engineering Edit / B.A. Hands/ Academic Press, 1986.
5. Cryogenic Engineering/ R.B.Scottm Vin Nostrand/ Inc. New Jersey, 1959.
6. Experimental Techniques in Low Temperature Physics- O.K. White, Oxford Press, 1968.
7. Cryogenic Process Engineering/ K.D. Timmerhaus & TM Flynn/ Plenum Press, 1998.
8. Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 1998.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

**SOLAR ENERGY TECHNOLOGY  
(ELECTIVE-I)****UNIT - I**

Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications.

Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

**UNIT - II**

**Design of Solar Water Heating System and Layout :** Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

**UNIT - III**

**Thermal Energy Storage:** Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations.

Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

**UNIT - IV**

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

**UNIT - V**

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

**REFERENCES:**

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/2<sup>nd</sup> edition.
2. Solar energy thermal processes/ Duffie and Beckman/John Wiley & Sons.
3. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/TMH/2<sup>nd</sup> edition.
4. Solar energy/ Garg/TMH.
5. Solar energy/ Magal/Mc Graw Hill.
6. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa.
7. Power plant Technology/ EI Wakil/TMH.

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 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

**ADVANCED I.C. ENGINES**
**(ELECTIVE-II)**
**UNIT - I:** Introduction – Historical Review – Engine Types – Design and operating Parameters.

**Cycle Analysis:** Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

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

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

**UNIT - III:**
**Engine Combustion in S.I Engines:** Combustion and Speed – Cyclic Variations – Ignition – Abnormal combustion Fuel factors, MPFI, SI engine testing.

**Combustion in CI Engines:** Essential Features – Types off Cycle. Pr. Data – Fuel

Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

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

**UNIT - V:**
**Engine Heat Transfer:** Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer , radiation heat transfer, Engine operating characteristics.

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

**Modern Trends in IC Engines:** Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.

**REFERENCES:**

1. I.C. Engines / V.Ganesan/TMH.
2. I.C. Engines Fundamentals/Heywood/TMH.
3. I.C. Engines/G.K. Pathak & DK Chevan/ Standerd Publications.
4. I.C. Engines /RK Rajput/Laxmi Publications.
5. Computer Simulation of C.I. Engine Process/ V.Ganesan/University Press.
6. Fundamentals of IC Engines/HN Gupta/PHI/2<sup>nd</sup> edition.
7. I.C. Engines/Fergnson/Wiley.
8. The I.C. Engine in theory and Practice Vol.I / Teylor / IT Prof. And Vol.II.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

**NON CONVENTIONAL ENERGY RESOURCES  
(ELECTIVE-II)****UNIT-I**

Introduction, Energy Scenario, Survey of energy resources. Classification and need for conventional energy resources.

**Solar Energy:** The Sun-sun-Earth relationship, Basic matter to waste heat energy circuit, Solar Radiation, Attention, Radiation measuring instruments.

**Solar Energy Applications:** Solar water heating. Space heating, Active and passive heating. Energy storage. Selective surface. Solar stills and ponds, solar refrigeration, Photovoltaic generation.

**UNIT -II**

**Geothermal Energy:** Structure of earth, Geothermal Regions, Hot springs. Hot Rocks, Hot Aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems.

**UNIT-III**

**Direct Energy Conversion: Nuclear Fusion:** Fusion, Fusion reaction, P-P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

**Hydrogen Gas as Fuel:** Production methods, Properties, I.C. Engines applications, Utilization strategy, Performances.

**UNIT-IV**

**Bio-energy:** Biomass energy sources. Plant productivity, Biomass wastes, aerobic and Anaerobic bioconversion processed, Raw metrical and properties of bio-gas, Bio-gas plant technology and status, the energetics and economics of biomass systems, Biomass gasification

**UNIT-V**

**Wind Energy:** Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, 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.

**REFERENCES:**

1. Renewable Energy Resources- Basic Principles and Applications/ G.N.Tiwari and M.K.Ghosal/ Narosa Publications.
2. Renewable Energy Resources/ John Twidell & Tony Weir/Taylor & Francis/2<sup>nd</sup> edition.
3. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/E&FN Spon.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

**MATERIAL SCIENCE  
(ELECTIVE - II)****UNIT – I:**

**Atomic and Ionic Arrangements:** Amorphous Materials : Principles and Technological Applications, Lattice, Unit cell, Basis, and Crystal Structures, Points, Directions, and Planes in the unit cell, Crystal Structures of Ionic Materials

**Implementation in the Atomic and Ionic Arrangements:** Point Defects, Dislocations, Significance of Dislocations, Schmid's Law, Surface defects

**UNIT – II:**

**Mechanical Properties: Fundamentals and Tensile, Hardness, and Impact Testing:** The Tensile Test: Use of the Stress – Strain Diagram, True Stress and True Strain, The Bend Test for Brittle Materials, Hardness of Materials, Strain Rate effects and Impact Behaviour

**Heat Treatment of Steels and Cast Irons:** Designations and Classification of Steels, Simple Heat treatments, Isothermal Heat treatments, Quench and Temper Heat treatments, Surface treatments, Weldability of Steel.

**UNIT – III:**

**Fracture Mechanics, Fatigue, and Creep Behaviour:** Fracture Mechanics, The Importance of Fracture Mechanics, Microstructural Features of Fracture in Metallic Materials., Microstructural Features of Fracture in Ceramics, Glasses, and Composites, Fatigue, Result of the Fatigue test, Application of Fatigue test, Creep, Stress Rupture, and Stress Corrosion, Evaluation of creep Behaviour

**UNIT – IV:**

**Polymers:** Classifications of Polymers, Typical Thermoplastics, Structure - Property Relationship in thermoplastics, Effect of Temperature on thermoplastics, Mechanical Properties of thermoplastics, Elastomers (Rubbers), Thermosetting Polymers

**Ceramic Materials:** Applications of Ceramics, Properties of Ceramics, Characteristics of Sintered ceramics, Glass Ceramics, Refractories.

**UNIT – V:**

**Composites: Teamwork and Synergy in Material:** Particulate Composites, Fibre – Reinforced Composites, Characteristics of Fibre – Reinforced composites, Manufacturing Fiber and Composites, Fiber Reinforced Systems and Applications, Laminar Composite Materials, Examples and Applications of Laminar Composites.

**REFERENCES:**

1. High temperature materials technology /Campbell E.E. and Sherwood /John Wiley and Sons, 1967.
2. High temperature technology /Campbell I.E. /John Wiley.
3. High temperature materials /Hehmann R.F./Wiley and sons/1967.
4. Behaviour of high temperature alloys/Proceeding of International conference/ 1979.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -I Sem. M.Tech (Thermal Engg.)

**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



## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

## 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.

Coal – Carbonisation, Gasification and liquification – Lignite: petroleum based fuels – problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas Alcohols and Biogas.

**UNIT – II :**

**Principles of Combustion:** Chemical composition – Flue gas analysis – dew point of products – Combustion stoichiometry.

Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroth, first, second and third order reactions - complex reactions – chain reactions. Theories of reaction Kinetics – General oxidation behavior of HC's.

**UNIT – III:**

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

**UNIT – IV:**

**Laminar and Turbulent Flames Propagation and Structure:** Flame stability – Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity.

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

**UNIT – V:**

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

**REFERENCES:**

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.
4. Principles of Combustion / Kenneth K. Kuo/ Wiley and Sons.
5. Combustion / Sarkar / Mc. Graw Hill.
6. An Introduction to Combustion / Stephen R. Turns/ Mc. Graw Hill International Edition.
7. Combustion Engineering / Gary L. Berman & Kenneth W. Ragland/ Mc. Graw Hill International Edition.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

**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 organizations. Initiating, Organizing 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 depreciation, Time value of money. Budget considerations, Risk analysis.

**UNIT-IV**

**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 method of analysis, Replacement analysis.

**UNIT-V**

**Alternative Energy Sources: Solar Energy:** Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

**REFERENCES:**

1. Energy Management Hand Book / W.C. Turner (Ed).
2. Energy Management Principles / CB Smith/ Pergamon Press.
3. Energy Management / W.R.Murthy and G.Mc.Kay / BS Publication.
4. Management / H.Koontz and Cyrill Donnel / McGraw Hill.
5. Financial Management / S.C.Kuchhal / Chaitanya Publishing House.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

## ADVANCED FINITE ELEMENT ANALYSIS

## UNIT-I

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

## UNIT-II

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

**Analysis of Trusses :** Plane Trusses and Space Truss elements and problems

**Analysis of Beams :** Hermite shape functions – stiffness matrix – Load vector – Problems.

## UNIT-III

**2-D Problems:** CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration.

Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.

**3-D Problems:** Tetrahedron element – Jacobian matrix – Stiffness matrix.

## UNIT-IV

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

## UNIT-V

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

## REFERENCES:

1. The Finite Element Methods in Engineering / SS Rao / Pergamon.
2. Finite Element Methods: Basic Concepts and applications, Alavala, PHI.
3. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall.
4. Finite Element Method – Zienkiewicz / Mc Graw Hill.
5. Introduction to Finite element analysis- S.Md.Jalaludeen, Anuradha Publications, print-2012.
6. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5<sup>th</sup> Edition.
7. Finite Element Method – Krishna Murthy / TMH.
8. Finite Element Analysis – Bathe / PHI.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

## COMPUTATIONAL FLUID DYNAMICS

(Elective-II)

## UNIT - I

**Introduction:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

**Solution Methods:** Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

## UNIT – II

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

## UNIT - III

**Formulations of Incompressible Viscous Flows:** Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

**Treatment of Compressible Flows:** potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

## UNIT - IV

**Finite Volume Method:** Finite volume method via finite difference method, formulations for two and three-dimensional problems.

## UNIT - V

**Standard Variational Methods:** Linear fluid flow problems, steady state problems, Transient problems.

## REFERENCES:

1. Computational fluid dynamics/ T. J.C'hung/ Cambridge University press, 2002.
2. Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985.
3. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.
4. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications.
5. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.
6. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.
7. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford University Press/ 2<sup>nd</sup> Edition.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

**EQUIPMENT DESIGN FOR THERMAL SYSTEMS  
(ELECTIVE- III)****UNIT -I:**

**Classification of Heat Exchangers:** Introduction, Recuperation & regeneration, Tabular 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 Tabular 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-II:**

**Double Pipe Heat Exchanger:** Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.

**Shell & Tube Heat Exchangers:** Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

**UNIT-III:**

**Condensation of Single Vapours:** Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam.

**UNIT-IV:**

**Vaporizers, Evaporators and Reboilers:** Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

**UNIT-V:**

**Direct Contact Heat Exchanger:** Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

**REFERENCES:**

1. Process Heat Transfer/D.Q.Kern/ TMH.
2. Heat Exchanger Design/ A.P.Fraas and M.N.Oziscij/ John Wiley & sons, New York.
3. Cooling Towers / J.D.Gurney and I.A. Cotter/ Maclaren.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

**CONVECTIVE HEAT TRANSFER  
(ELECTIVE-III)****UNIT-I:**

Introduction to Forced, free & combined convection – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers.

**Equations of Convective Heat Transfer:** Continuity, Navier-Stokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

**UNIT-II:**

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

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

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

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

**UNIT – III:**

**Natural Convection:** Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations.

Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

**UNIT – IV:**

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

**UNIT - V:**

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

**REFERENCES:**

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

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

**THERMAL AND NUCLEAR POWER PLANTS  
(ELECTIVE-III)****UNIT -I**

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

**Steam Power Plant:** Introduction. General layout of steam power plant, Modern coal. Fired Steam, Steam power plant. Power plant cycle, Fuel Handling, Combustion equipment, Ash handling, Dust collectors.

**Steam Generators:** Types, Accessories. Feed water heaters, Performance of boiling, Water treatment, Cooling towers. Steam turbines. Compounding of turbines, Steam condensers, Jet and surface condensers.

**UNIT-II**

**Gas Turbine Power Plant:** Cogeneration. Combined cycle power plant, Analysis, Waste heat recovery, IGCC power plant, Fluidized bed, Combustion, Advantages, Disadvantages

**UNIT-III**

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

**UNIT-IV**

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

**UNIT-V**

**Power Plant Instrumentations:** Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.

**REFERENCES:**

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

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

THERMAL MEASUREMENTS AND PROCESS CONTROLS  
(ELECTIVE-IV)**UNIT-I**

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

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

**UNIT-II**

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

**UNIT-III**

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

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

**UNIT-IV**

**Level Measurement:** Direct & indirect methods, manometric methods, float level meters, electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods.

Measurement of density – Hydrometer, continuous weight method, Gamma rays, Gas impulse wheel.

Velocity Measurement – Coefficient of viscosity, Ostesld method, free fall of piston under gravity, torque method.

Measurement of moisture content and humidity.

Measurement of thermal conductivity of solids, liquids and gases.

**UNIT-V**

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

Control System Evaluation – Stability, steady state regulations, transient regulations.

**REFERENCES:**

1. Measurement System, Application & Design – E.O. Doebelin.
2. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
3. Mechanical Measurements – Buck & Beckwith – Pearson.
4. Control Systems, Principles & Design, 2<sup>nd</sup> Edition – M. Gopal – TMH.



## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

REFRIGERATION AND AIR CONDITIONING  
(ELECTIVE-IV)

## UNIT – I

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

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

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

## UNIT – II

**Production of Low Temperature:** Liquefaction system ; Cascade System – Applications. – Dry ice system.

**Vapor absorption system** – Simple and modified aqua – ammonia system – Representation on Enthalpy – Concentration diagram.

Lithium – Bromide system Three fluid system – HCOP.

## UNIT – III

**Air Refrigeration:** Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.

**Steam Jet Refrigeration System:** Representation on T-s and h-s diagrams – limitations and applications.

**Unconventional Refrigeration System** – Thermo-electric – Vortex tube & Pulse tube – working principles.

## UNIT – IV

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

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

## UNIT – V

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

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

## REFERENCES:

1. Refrigeration & Air Conditioning /C.P. Arora/TMH.
2. Refrigeration & Air Conditioning /Arora & Domkundwar/ Dhanpat Rai.
3. Refrigeration and Air Conditioning /Manohar Prasad.
4. Refrigeration and Air Conditioning /Stoecker /Mc Graw Hill.
5. Principles of Refrigeration/Dossat /Pearson.
6. Refrigeration and Air Conditioning /Ananthanarayana /TMH.
7. Refrigeration and Air Conditioning /Jordan & Preister /Prentice Hall.
8. Refrigeration and Air Conditioning/Dossat /Mc Graw Hill.

## JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

JET PROPULSION AND ROCKETRY  
(ELECTIVE-IV)**UNIT - I:**

**Turbo Jet Propulsion System:** Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery-compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

**Flight Performance:** Forces acting on vehicle – Basic relations of motion – multi stage vehicles.

**UNIT - II:**

**Principles of Jet Propulsion and Rocketry:** Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet, turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

**Nozzle Theory and Characteristics Parameters:** Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient,  $A_c / A_e$  of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

**UNIT - III:**

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

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

**UNIT - IV:**

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

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

**UNIT - V:**

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

**REFERENCES:**

1. Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley & Sons.
2. Rocket propulsion elements/Sutton/John Wiley & Sons/8<sup>th</sup> Edition.
3. Gas Turbines/Ganesan /TMH.
4. Gas Turbines & Propulsive Systems/Khajuria & Dubey/Dhanpat Rai & Sons.
5. Rocket propulsion/Bevere.
6. Jet propulsion /Nicholas Cumpsty.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

I Year -II Sem. M.Tech (Thermal Engg.)

**COMPUTATIONAL METHODS LABORATORY**

C programming for problem solving.

Solving Thermal Engineering problems using available packages such as T K Solver, ANSYS, CFX, STARCD, MATLAB, FLUENT etc...