ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.TECH
ENERGY SYSTEMS

(Applicable for the batches admitted from 2013-14)

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

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

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:

Civil Engg.	Construction Management Environmental Engineering Geoinformatics and Surveying Technology Geotechnical Engineering Highway Engineering Infrastructure Engineering Structural Engineering Transportation Engineering
EEE	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
ME	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.
ECE	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
CSE	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
Aeronautical Engg.	Aerospace Engineering / Aeronautical Engineering
Bio-technology	Bio-Technology
Chemical Engg.	Chemical Engineering
Nano Technology	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:

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

The marks in internal evaluation and end examination shall be shown separately in the 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
	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.	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.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.TECH - ENERGY SYSTEMS

COURSE STRUCTURE AND SYLLABUS

I Year I Semester

Code	Group	Subject	L	P	Credits
		Applied Thermodynamics	3	-	3
		Advanced Heat and Mass Transfer	3	-	3
		Industrial Instrumentation and Control Engineering	3	-	3
		Renewable Energy Technologies	3	-	3
	Elective –I	Computational Methods Thermal Power Plants Hydrogen and Fuel Cells Energy Policy, Ecology and Environment	3	-	3
	Elective -II	I.C Engines & Alternate Fuels Nuclear Energy Design of Experiments Pollution Control in Power Plants	3	-	3
	Lab	Modelling and Simulation Laboratory	-	3	2
		Seminar	-	-	2
		Total Credits	18	3	22

I Year II Semester

Code	Group	Subject	L	P	Credits
		Photovoltaic & Solar Thermal Systems	3	-	3
		Design and Optimisation of Energy Systems	3	-	3
		Thermal Energy Management and Conservation	3	-	3
		Electrical Energy Management and Conservation	3	-	3
	Elective–III	Advanced Control Systems Steam and Gas Turbines Hydel Power Engineering Solar Refrigeration and Air Conditioning	3	-	3
	Elective-IV	Bio-Conversion & Processing of Waste Cogeneration Green Buildings concepts Computational Fluid Dynamics	3	-	3
	Lab	Energy Systems Laboratory	-	3	2
		Seminar	-	-	2
		Total Credits	18	3	22

II Year - I Semester

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

II Year - II Semester

Code	Group	Subject	L	P	Credits
		Project work and Seminar	-	-	22
		Total Credits	-	-	22

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

APPLIED THERMODYNAMICS

Unit-I

Introduction: Thermodynamic system - types –properties – Laws of thermodynamics – Concepts of entropy - Second Law of thermodynamics – Clausius inequality – Available energy – irreversibility - Properties of working substances: Pure substance – phases – phase change process – property diagrams – Ideal Gas equation of state – Real gas behavior - Compressibility factor – properties – other equations of state – throttling – Joule Thomson Coefficient - Composition of a Gas mixture – mass and mole fractions – Properties of gas mixtures (Ideal and Real gases).

Unit-II

Thermodynamic potentials – Maxwell's relations – Clausius Clayperon equation – General relations for du, dh, ds, C_v ,C_p for ideal gases (pure substances) and real gases (No derivations and problems) - Theoretical and actual combustion processes – Enthalpy of formation – Enthalpy of Combustion – First Law analysis of Reacting Systems – Adiabatic flame temperature – Entropy change of Reacting mixtures – Second Law analysis of Reacting systems.

Unit-III

Gas power cycles: Carnot cycle - Air standard assumptions - Otto cycle - Diesel cycle – Dual cycle – Stirling cycle – Ericsson cycle – Brayton cycle – Brayton cycle with Intercooling, Reheating and Regeneration.

Unit-IV

Vapor power cycles (Elementary treatment only): Carnot vapor cycle – Ideal Rankine cycle – Deviation of Actual Vapor power cycle from Ideal cycle – Actual Rankine cycle – Methods to increase efficiency of Rankine cycle (Lowering of condenser pressure, Super heating steam to High temperature, Increasing Boiler pressure) – Reheat and Regenerative Rankine cycle.

Unit-V

Refrigeration cycles – applications – air refrigeration – vapour compression refrigeration – effect of operating parameters – COP – vapour absorption refrigeration system.

Reference Books:

1. Thermodynamics – An Engineering Approach / Y.A.Cengel and Mc. A. Boles.
2. Basic and Applied Thermodynamics / P.K.Nag /TMH.
3. Thermodynamics / Sontag & Van Wylen.
4. Thermodynamics / YVC RAO.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

ADVANCED HEAT AND MASS TRANSFER

Unit-I

Conduction: Introduction – Modes of heat transfer – Combined modes – Steady one-dimensional – Steady heat source system – Steady porous system – Steady two-dimensional system – Unsteady Conduction - Lumped heat capacity system, infinite solid flat plate, and cylinder – Semi-infinite bodies.

Unit-II

Convection: Boundary layer flow with heat transfer - Equations of momentum and energy – Integral method of solution – Empirical relations for other configurations - Free Convection from vertical, horizontal and inclined plates - Mechanism of free convection in enclosed spaces – Mixed convection.

Unit-III

Radiation – Overview of Mechanism – Radiant heat exchange in gray, non-gray bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation.

Unit-IV

Phase Change - Regimes of pool boiling – Flow boiling – Correlations - Types of condensation – Film condensation on horizontal and vertical surfaces.

Unit-V

Mass Transfer – Diffusion and Convective mass transfer - Fick's law of diffusion, Analogy with momentum and energy transport, Diffusivities of gases and liquids – Definition of mass transfer conductance and driving force – Fundamentals of mass transfer coefficient – Equations of the concentration boundary layer – Dimensionless numbers and significance – Mass transfer correlations.

Reference Books:

1. Heat Transfer - A basic approach / Necati Ozisik/ Mc Graw Hill.
2. Fundamentals of Heat and Mass transfer by Incropera and Dewit, Wiley.
3. Heat transfer by Cengel and Boles, TMH.
4. Heat Transfer / Ghoshdastidar / Oxford University Press.
5. Convective Heat Transfer Analysis /Patrick H.Oosthuizen/David Naylor/ McGraw Hill.
6. Convective Heat and Mass Transfer / W.M.Kays & Craford/ TMH.
7. Mass Transfer Operations / Robert E. Treybal / Mc Graw Hill.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

***INDUSTRIAL INSTRUMENTATION AND CONTROL ENGINEERING**

Unit-I

Elements of a Measurement System; Basic Instrumentation system; Errors and Uncertainties;Mechanical Transducers: Temperature- Bimetallic Element and Fluid Expansion type Thermometers; Pressure-Manometers and Bourdon Gauges; Load Cells and Elastic Force Devices;Electrical transducers: Resistive Transducers; Inductive Transducers; Capacitive transducers; Thermoelectric Transducers and Photoelectric Transducers; Piezoelectric Transducers.

Unit-II

Basic Signal Conditioning Elements: DC Bridges, AC Bridges, Wheatstone Bridge, Balance & Deflection Measurements - Amplifiers- Non Electrical and Electrical types; Op Amps- Summing, Differential, and Charge Amplifiers; Differentiating and Integrating Elements; Filters; Data Transmission Elements- Electrical, Pneumatic, Position and Radio Frequency Transmission types, Basic display elements.

Unit-III

Industrial Measurements Velocity Measurement – Contact type: AC-DC Tachometers Non contact type: Magnetic, Photoelectric & stroboscopic methods Acceleration measurement – Seismic Accelerometer & Piezoelectric Accelerometer Measurement of Force – Different methods; Strain gauge load cell method Measurement of torque – Strain gauge method Radiation Measurement – Radiation Fundamentals; Radiation detectors; Optical pyrometer.

Unit-IV

Control Systems: Open & Closed loop systems, Linear Time-invariant systems, Transfer Function Analysis, Mason's Gain Formula, Transient response analysis, Stability Analysis, RH Criterion, Relative stability.

Unit-V

Frequency response analysis: Bode plots, Nyquist Stability Criterion, Gain Margin & Phase Margin (Simple problems only)-Introduction to State Space Analysis(Elementary treatment only – No numerical); Concept of state, state variables & state models; State transition matrix.

* ***Being a descriptive & inter disciplinary course NO NUMERICALS are envisaged in this course except for unit IV***

Reference Books:

1. Albert D Helfrick and William D Cooper; Modern Electronic Instrumentation and Measurement Techniques; 2004, PHI.
2. BC Nakra, and KK Chaudhry; Instrumentation, Measurement and Analysis; 2 ed, 2004, Tata McGraw-Hill.
3. DVS Murthy; Transducers and Instrumentation; 2003, PHI.
4. CS Rangan, GR Sarma, and VSV Mani; Instrumentation Devices and Systems; 2 ed, Tata McGraw-Hill.
5. Doeblin and Ernest; Measurement Systems Application and Design; 5 ed, 2004, Tata McGraw-Hill.
6. Measurement Systems – Applications & design by Doeblin E.O. 4th ed. Mc. Graw Hill.
7. Principles of Industrial Instrumentation by Patranabis D. TMH – 1997.
8. Mechanical & Industrial Measurements by Jain R.K, Khanna Publishers – 1986.

9. Process Instruments and control Hand book by Considine D.M, 4th ed, Mc.Graw Hill.
10. Instrument Technology – Vol 1 by Jones E.B., Butterworths – 1981.
11. Control Systems Engineering by Nagrath & M.Gopal, Wiley Eastern.
12. Automatic Control Systems by B.C.Kuo, John Wiley, 2009.
13. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

RENEWABLE ENERGY TECHNOLOGIES

Unit-I

Wind Energy – Power in wind - Availability – Types of wind turbines - Aerodynamics of Wind turbine – Momentum theory – Dynamic matching, Construction features of wind turbines - Rotor design considerations – Power extraction by a turbine – Integration of wind energy converters to electrical networks -Applications of wind energy

Unit-II

Biomass energy - Bio Fuel – Conversion of Biomass – Bio fuel classification- Biomass production for Energy farming- Direct combustion for heat- Pyrolysis- Thermo chemical process- Anaerobic digestion- Digester sizing- waste and residues- vegetable oils and biodiesels- Applications of Biogas-Social and environmental aspects

Unit-III

Wave and Tidal Energy - Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conversion devices (Tapchan, oscillating water column type); Principles of tidal power generation - components of power plant – Single and two basin systems – Estimation of energy – Maximum and minimum power ranges

Unit-IV

Ocean and Geothermal Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - Heat exchanger calculations (elementary treatment) – Major problems and operational experience - Classification of geothermal resource - Fundamentals of geophysics - Availability and estimation of thermal power - Extraction techniques.

Unit-V

The Hydrogen economy – Advantages of hydrogen as an energy carrier – Components of the hydrogen economy - Generation of hydrogen - Transport and storage of hydrogen: physical and chemical - Fuel Cells – Classification of fuel cells based on (a) Type of electrolyte (b) Type of the fuel and oxidant (c) operating temperature (d) application and (e) chemical nature of electrolyte

Reference Books:

1. Renewable Energy Resources / John Twidell and Tony Weir / E & F.N.Spon.
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa.
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH.
4. Solar Energy Thermal Processes,/Duffie & Beckman.
5. Solar Heating and Cooling / Kreith & Kreider.
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / Wiley.
7. Wind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford.
8. Biogas Technology - A Practical Hand Book / K.Khendelwal & S.S. Mahdi / McGraw-Hill.
9. Power Plant Technology / El Wakil/ Mc Graw Hill.
10. Fuel cell/Livin Oniciu/Abacus press 1976.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

COMPUTATIONAL METHODS

(Elective-I)

Unit-I

Finite differences – Forward, Backward and Central difference approximations to derivatives – Croutes method, Jacobi's Method – Gauss Siedel iterative method - successive over-relaxation method.

Unit-II

Methods of engineering analysis: Introduction of Treatment of experimental, analytical and numerical methods, Errors - Truncation and Rounding off - Finite Element Method. Comparison of F E M with Finite Difference methods - Raleigh Ritz method, concept of Potential Energy – Gelarkin's method.

Unit-III

Introduction to FEM: Basic concepts – Historical background – General Applications of FEM –Steps involved in F E M, descritization of domain - Basic element shapes and types-Characteristics of finite elements- Location of nodes-node numbering scheme-Degree of freedom-interpolation models – convergence requirements.

Unit-IV

Finite element modeling– One dimensional problem - coordinates and shape functions for 1-D problems – Applications to solid mechanics: load stess, strain, displacement and their relationships.-Formulation of stiffness matrix and load vectors. Properties of stiffness matrix –Temperature effects-some simple problems on 1-D solid mechanics.

Unit-V

Two dimensional problems – Introduction to Plane stress and plane strain-2-D modeling – Constant strain triangle – boundary condition –Shape functions for a CST element. Element stiffness matrix- Isoparametric representation. Basic equations of heat transfer-steady state heat transfer-heat conduction- some typical problems in heat transfer.

Reference Books:

1. Introduction to Numerical Methods/ S.S.Sastry.
2. Numerical Methods /B.S.Grawel.
3. Computational Fluid flow and Heat transfer / Edt.K.Muralidhar and T.Sundararajan / Narosa.
4. Finite Elements in Engineering / S.S.Rao.
5. Introduction to Finite Element Engineering/T.R.Chandrupatla and A.D. Belagundu.
6. Finite Element engineering -Jalaluddin.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

THERMAL POWER PLANT

(Elective-I)

Unit-I

Fuels and Combustion - Types of fuels – Coal firing – Pulverization of solid fuels – Fuel handling systems – Coal cycle – Ash cycle – Types of Furnaces – Fluidized bed combustion (FBC) – Liquid and gaseous fuels – By products of combustion (simple problems) – Heat of combustion – Combustion temperatures – Stack.

Unit-II

Steam Generators and Accessories - Steam generators – Classification – Types – High-pressure boilers – Super critical boilers – Steam piping Accessories - Super heaters – Reheaters – Economizers – Air Preheaters - Pumps and Fans - Types of Condensers – direct contact condensers - surface condensers - Feed water heaters – Types – Boiler Makeup – Evaporators - Condensate circulation system – Cooling towers – Types – wet and dry cooling towers.

Unit-III

Steam Turbines (Illustrative problems only) - Classification – HP/IP/LP Turbines - Impulse turbines – Reaction turbines – Compounding – Steam compounding – Velocity compounding – Advantages and disadvantages – Governing – Turbine losses – Turbine efficiencies – Turbine materials.

Unit-IV

Gas Turbines (Illustrative problems only) - Gas Turbine cycle – Combined cycle analysis – Design for high temperature combined cycles with heat recovery boiler – Combined cycle power plant – Combined cycle with multi pressure steam, Influence of component efficiencies on cycle performance – IGCC plant.

Unit-V

Power Plant Layout and Economics - General layout of modern thermal power plants – Advanced layouts – Plant efficiency and economics - Environmental aspects of thermal power plants - Constituents of the atmosphere – Dust collectors - Oxides of Sulfur, Nitrogen and Carbon – Greenhouse effect – Acid precipitation – Particulate matter – Electrostatic precipitators – Thermal pollution.

Reference Books:

1. A course in Power Plant Engineering/ Arora and Domkundwar/ Dhanpat Rai.
2. Power Plant Engineering / G.R. Nagpal/Khanna Publishers.
3. Power Plant Technology / El Wakil/ Mc Graw Hill.
4. Power Plant Technology/ Rajput.
5. Power Plant Engineering / P.K.Nag / Tata McGraw Hill.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

HYDROGEN AND FUEL CELLS (Elective)

(Elective-I)

Unit-I

Hydrogen and Production Techniques: Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

Unit-II

Hydrogen Storage and Applications: Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Hydrogen transmission systems. Applications of Hydrogen.

Unit-III

Fuel Cells: History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell

Unit-IV

Fuel Cell – Types: Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits

Unit-V

Application of Fuel Cell and Economics: Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

Reference Books:

1. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma (2005).
2. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK (2005).
3. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany (1996).
4. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork Ltd., London (1989).
5. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA (2002).
6. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press (2006).

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

ENERGY POLICY, ECOLOGY AND ENVIRONMENT

(Elective-I)

Unit-I

Energy and us: Energy terms; Current energy scenario (World, US, India); Fossil energy Vs renewable sources; Electricity; Future projection.

Unit-II

Carbon Cycle: Natural systems - autotrophs, heterotrophs, energy flows, pre-industrial humanity; Photosynthesis- efficiency of natural ecosystems, forests and crops types; Respiration, combustion and other oxidation processes; Biomethanation.

Unit-III

Climate Science Research: Climate history; Greenhouse gas effect; climate change; Role of different gases; Global problem; Integrated assessment models; Impacts and adaptation; Precautionary principle.

Unit-IV

Carbon Sequestration: Biological pathways; Physico-chemical methods; CO2 capture ; Pre-, post- and oxy-combustion technology; Transport, storage and monitoring; Feasibility, economics and public perceptions; Case studies.

Unit-V

Climate Policy: Kyoto protocol; UNFCCC; IPCC; Geopolitics of GHG control; Carbon market - CDM and other emission trading mechanisms; Non-CO2 GHGs; Relevance for India.

Reference Books:

1. Energies: V Smil, MIT Press, Cambridge, 1999.
2. Global Warming: J Houghton, Cambridge University Press, New York, 1997.
3. Various reports published by IPCC: http://www.ipcc.ch/, 1990 onwards.
4. IPCC Special Report on Carbon Dioxide Capture and Storage: B Metz et al (Eds), Cambridge University Press, NY, 2005.
5. CDM Country Guide for INDIA: Institute for Global Environmental Strategies (Ed), Ministry of the Environment, Japan, 2005.
6. Global Environmental Issues:F Harris (Ed),John Wiley,Chichester, 2004.
7. Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation? edited by E J Wilson and D Gerard, Blackwell Publishing, Ames, Iowa, USA, 2007.
8. Energy and the environment: J A Fay and D S Golomb, Oxford University Press, New York, 2002.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

I.C.ENGINES & ALTERNATE FUELS

(Elective-II)

Unit-I

Fuels & Cycle Analysis: Broad classification of fuels - Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles - Engine Types – Design and operating Parameters – Real Engine cycles difference and responsible factors.

Unit-II

Gas Exchange Processes & Charge Motion: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging. Exhaust gas recirculation system and their designing -Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

Unit-III

Combustion in S.I Engines: Normal and Abnormal Combustion, Flame speed and factors influencing it-Factors affecting knock - Combustion in CI engines – Different stages of combustion – knocking in diesel engines – importance of ignition delay – Heat release rate in C.I engines – Factors affecting combustion and knock – Fuel spray in diesel engines and air movement.

Unit-IV

Pollutant Formation and Control: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, Unburnt Hydrocarbon and particulate emission – Measurement – Exhaust Gas Treatment. Catalytic converter, 2 way type & 3 way type.

Unit-V

Modern Trends in IC Engines: Lean Burning and Adiabatic concepts - Rotary Engines. Modification in IC Engines to suite Bio-Fuels - Fuel supply systems for SI and CI engines to use gaseous fuels like LPG, CNG, and Hydrogen – Concepts of Homogenous Charge Compression Ignition (HCCI) & Gasoline Direct Injection (GDI) - Computer Simulation and Optimized Design.

* This is a descriptive course, hence numerical problems are not envisaged.

Reference Books:

1. I.C. Engines Fundamentals/Heywood/McGraw Hill.
2. I.C. Engines /Ferguson.
3. I.C. Engines / Maleev.
4. I C Engines / V Ganesan.
5. I.C. Engine in theory and Practice Vol. I and II / Taylor.
6. I.C. Engines / Obert / Int.Text Book Co.
7. Combustion Engine Processes / Lichty.
8. Scavenging of two stroke Cycle Engines / Switzer.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

NUCLEAR ENERGY

(Elective-II)

Unit-I

Nuclear Fuel and Reactor Theory: Nuclear fuels-occurrence and extraction, fissile characteristics, enrichment, fission process - thermal and fast fission - energy released from fission - chain reaction - reaction control.

Neutron balance - fast fission - resonance capture – thermalisation - geometric effects - burn-up – introduction to reactor kinetics.

Unit-II

Nuclear Reactors: General components of nuclear reactor - Fuel cladding - fuel assembly – moderators – coolants - control rods -Different types of reactors - Pressurized Water Reactor - Boiling Water Reactor - Heavy Water cooled Reactor -Gas cooled Reactor - Liquid metal cooled reactor - Organic moderated and cooled reactors - Fast Breeder Reactors - Reactor safety - Neutron Population growth - assurance of safety -emergency core cooling and containment.

Unit-III

Radioactive Waste Management: The nuclear fuel cycle - Waste classification - Spent fuel storage – Transportation – Reprocessing - High-Level waste disposal - low-level waste generation and treatment - Low-level waste disposal - Nuclear power plant decommissioning.

Unit-IV

Biological and Environmental Effects: Biological effects of radiation - radiation dose - Basic for limits and exposure - Sources of radiation dosage -Gas counters - Neutron detectors - Scintillation counters - Solid state detectors - Statistics of counting - Pulse height analysis - Protective measures - calculation of dose - effects of distance and shielding - Internal exposure - The Radon problem - Environmental radiological impact - radiation standards.

Unit-V

Nuclear Power for Propulsion and Energy Economics: Reactors for naval propulsion - Space reactors - Space isotopic power generator - Energy economics -Components of electrical power – cost forecast versus Reality - Challenges and opportunities - Technical and institutional improvements – Developments in nuclear reactor.

Reference Books :

1. W.Marshall, Nuclear Power Technology, Vol. I &II, Clarendon press, Oxford, 1985.
2. Samual Glasstone, Principle of Nuclear Reactor Engineering, Van Nostrand ReinholdCo. Inc., New York, 1963.
3. Margulova, Nuclear Power Station, Mir Publishers, Moscow, 1978.
4. Archie W.Culp, Principle of Energy Conversion, McGraw Hill Kogakusha Ltd., 1984.
5. Domkundwar, A Course in Power Plant Technology, Dhanpat Rai Sons.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

DESIGN OF EXPERIMENTS

(Elective-II)

Unit-I

Total Quality Management – Quality Function Development – Product and Process Optimization – Process Capability – Basics of DOE

Unit-II

Need for planned experimentation – steps in experimentation – comparison of Design of Experiments – loss function – Response Factors – Levels - Treatment combination – Effect of a factor – Experimental error – Data Analysis

Unit-III

Experimental Design – Factorial Experiments – Fractional Factorial Experiments – Taguchi's Method – Orthogonal array Design and Development – Linear Graph – interaction effect – Analysis of Variance.

Unit-IV

Optimization of Process parameter – Optimization strategy – Selection and identification of parameters – Response Graph Analysis – Signal to noise ratio analysis – Gray relational analysis

Unit-V

*****Optimization of cost and quality – Artificial Neural Network – Genetic Algorithms – Simulated Annealing Algorithm – Ant Colony Algorithm – Fuzzy logic approach

***** Simple treatment only

Reference Books:

1. Douglus C Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 1984.
2. Charles R Hicks, Holt, Rinchort and Winston, Fundamental concepts in design of experiments, 1984.
3. Phadke, M S, Quality Engineering using robust design, Prentice Hall, 1989.
4. Ross J Philip, Taguchi Techniques for quality engineering, McGraw Hill, 1989.
5. Genichi Taguchi, System of Experimental Design, UNIPUB, Karus International Publication, 1987.
6. Deb, K., Optimization for engineering design, Prentice Hall of India, 2005.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

POLLUTION CONTROL IN POWER PLANTS

(Elective-II)

Unit-I

Coal and Nuclear based Power Plants – Fly Ash generation and environment impact, Fly ash utilization and disposal,

Unit-II

Nuclear fuel cycle, Radioactive wastes – treatment and disposal,

Unit-III

Pollution control methods (i) Pre-combustion controls, (ii) Combustion controls Low NOx burners,

Unit-IV

Fluidized bed boilers, (iii) Post Combustion Controls, Particulate controls, Cyclone, Wet scrubbers, ESP and fabric filters,

Unit-V

Gaseous pollutants controls flue gas desulfurization (FGD) systems, CSR reduction applications of electron beam and non thermal plasmas for SOx and NOx treatments, Thermal pollution and its impact on aquatic life.

Reference Books:

1. M. Giblbert Masters. Introduction to Environmental Engineering and Science, Prentice Hall, 1991.
2. C. S. Rao. Environmental Pollution Control Engineering. Wiley Eastern Ltd. Delhi 1991.
3. Subodh Kumar and C. B. Patil. Estimation of resource savings due to fly ash utilization in road construction. Resource conservation and Recycling, 48, 125-140 (2006).
4. U. Bhattcharjee and T. C. Kandpal. Potential of fly ash utilization in India. Energy 27, 151-66, 2002.
5. TIFAC (Technology Information Forecasting and assessment Council) Home page http:// www.tifac.org.in/news/flyindia.htm.2005.
6. H. Etherington. Nuclear engineering handbook. McGraw Hill (New York) 1958.
7. P. K. Nag. Power Plant Engineering, Tata McGraw Hill (2001).
8. Samir Sarkar. Fuel and Combustion . Orient Longman Limited. (Hydrabad), 2001.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –I Sem (Energy Sys)

MODELING AND SIMULATION LABORATORY

WRITING PROGRAMS AND DEMONSTRATION

1. Declination of earth, hour angle, day length, local apparent time
2. Monthly average, hourly global and diffuse radiation on a horizontal surface and tilted surfaces.
3. Power generation from a wind turbine, Variation of wind velocity and power with altitude
4. Solution of ordinary differential eqations-4th order R K Method
5. Solution of one-dimensional steady state heat conduction equation
6. Solution of two-dimensional steady state PDE
7. Solution of one-dimensional transient PDE

FINITE ELEMENT ANALYSIS

8. Two dimensional heat conduction
9. One dimensional transient heat conduction
10. Transient analysis of a casting process

CFD ANALYSIS

11 Flow through a pipe bend

12. Flow through a nozzle

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

PHOTOVOLTAIC AND SOLAR THERMAL SYSTEMS

Unit-I

Solar Radiation and Measurements : Solar radiation - Energy Balance, Earth sun-angles-Types of Radiation, Measurements, solar Charts-Empirical equations for predicting the availability of solar radiation – Computation of radiation on inclined surfaces- Solar radiation data

Unit-II

Photovoltaic Fundamentals: Place of PV in energy supply – PV Modules and cost-review of semiconductor physics and Operating principle-–Introduction to P-N junction: Equilibrium and non equilibrium conditions-Design of solar cells: Cell parameters limits-Losses in solar cells-Solar cell design for high $I_{sc,}$, V_{oc} and FF.

Unit-III

Solar cell technologies: Si wafer based solar cell:Process of solar cell technology-Efficiency of Si cells; Thin film technologies:Materials-deposition techniques-Amorphous Si cells- Cadmium telluride celss-Thin film crystalline and poly crystalline Si cells-concentrator technologies-Optics for concentrators PV-Tracking requirements-High concentrator solar cells-Emenrging solar cell technologies.

Unit-IV

PV module and PV System applications: Solar PV modules-Mismatch in series and parallel connection-design & structure of PV modules-PV module power output-Bateries for PV systems-DC to DC and DC to AC converters-charge controllers-MPPT;Stand alone PV systems-Design methodolohy of PV systems-Wire sizing in PV systems-Grid connected and hybrid PV systems.

Unit-V

Solar Thermal Systems and applications: Solar Flat plate collectors, Concentrating Collectors, Compound Parabolic Collector, Collector Efficiency. Solar water heating Systems, Solar Cookers, Solar Dryers and Industrial Process heating.

Reference Books :

1. Generating Electricity from the Sun/Edited by Fred C. Treble/Pergamon Press.
2. Solar photovoltaics-Fundamentals ,technologies and Applications/Chetan Singh Solanki/PHI Learning private Ltd.New Delhi.
3. Terrestrial Solar photovoltaics/Tapan Bhattacharya/Narosa Publishing House.
4. Solar Electricity /Edited by Tomas Markvart/John Wiley and Sons.
5. Solar Cells – Operating Principles, Technology and System Applications /Martin A. Green/Prentice Hall Inc.
6. Modelling Photovoltaic Systems using P Spice/Luis Castaner and Santiago Silvestre/John Wiley and Sons.
7. Solar Energy – Fundamentals and Applications/H.P. Garg and J. Prakash / Tata McGraw-Hill.
8. Amorphous Silicon Solar Cells/K.Takahashi and M.Konagai/North Oxford Academic.
9. Photovoltaic Systems Engineering/Roger Messenger/CRC Press.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

DESIGN AND OPTIMIZATION OF ENERGY SYSTEMS

Unit-I

Thermal Systems – Characteristics- formulation of design problem-Steps in the design process- Modeling of thermal systems-importance- Types of models-Mathematical Modeling

Unit-II

Constrained Optimization – Linear programming models – Formulation - Simplex method – Artificial variable technique – Big M method-Concept of Sensitive analysis - Lagrangian multiplier – Application to thermal and electrical systems

Unit-III

Unconstrained Optimization: Single variable optimization – Fibonacci & Golden section method - Non-linear optimization - Multi variable optimization – Gradient methods – Gradient of the function - Steepest descent – Conjugate direction methods – Flecher-Reeves method -Variable metric method

Unit-IV

Geometric programming– Posynomial – Arithmetic and Geometric inequalities – Unconstrained GP - Constrained GP with constraints of type less than or equal- Application to thermal and electrical systems- Dynamic Programming- Bellman's principle of optimality- Shortest route problems.

Unit-V

Simulation - Definition- Types of Simulation models - Steps involved in simulation models-Application of simulation - Advantages and disadvantages – Introduction to Genetic algorithm – Genetic operators.

Reference Books:

1. Design and Optimization of Thermal Systems / Yogesh Jaluria / McGraw Hill.
2. Optimization theory and applications / S.S.Rao / New Age Publication.
3. Design of Thermal System / W.F.Stoecker / McGraw Hill.
4. Operation Research / Panner Selvam / Prentice Hall.
5. Optimization Research / M.C.Joshi.
6. Simulation Modeling & Analysis / Law & Kelto.
7. Operation Research / S Prinsc Valle Kasur.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

THERMAL ENERGY MANAGEMENT AND CONSERVATION

Unit-I

Energy Management : Definition, Scope of energy management, General Principles, Objectives and necessary steps energy management, Energy Manager- Qualifications, Functions, Duties and guidelines, Language. Energy Action Planning, Energy Monitoring and Targeting, Bench Marking.

Unit-II

Energy Auditing : Energy Surveying, Energy Audit - Purpose, Definition and Objectives, Types of Energy Audit-Preliminary and Detailed, Questionnaire Energy Audit Instruments, Thermal Energy measurements, observations, and Data analysis, Energy saving potential.

Unit-III

Energy Conservation: Introduction, Indian Energy Conservation Act, List of Energy Intensive Industries, Rules for Efficient Energy Conservation, Identification of Energy Conservation opportunities, Technologies for Energy Conservation, Energy Conservation Schemes and Measures, Energy flow net works, Critical assessment of energy use. Optimizing Energy Inputs and Energy Balance, Pinch Technology.

Unit-IV

Energy Efficiency Improvement of Thermal Systems : Steam Generation, Distribution and Utilization, Furnaces, Fans and Blowers, Compressors Pumps, Pinch Technology, Fluidized bed Combustion, Heat Exchanger Net works, Case Studies, analysis and recommendation.

Unit-V

Heat Exchangers and Heat Recovery Systems: Heat Exchangers - Classification – Over all heat transfer coefficient, Fouling factor, Design of heat exchangers by L.M.T.D. and N.T.U. methods. Liquid-to-Liquid heat exchangers Shell and tube Heat exchanger. Sources of waste heat , Guidelines to identify waste heat, Grading of waste heat , Feasibility study of waste heat recovery, Gas to Gas and Liquid to liquid heat recovery, waste heat boilers.

References Books:

1. Energy Conservation/ Paul O' Callaghan/ 1981.
2. Energy Management And Conservation /K V Sharma and P Venkataseshaiah.
3. Energy Management/ Paul O' Callaghan/ Mc Graw Hill/ 1992.
4. Heat Recovery Systems / D.A.Reay / E and F.N.Spon / 1979.
5. Energy Management, / Murphy W.R. and Mckay G/ Butterworth London, 1982.
6. Plant Engineers and Managers guide to Energy Conservation /Albert Thumann / Nost and Reinhold Co., New York.
7. Energy Management Principles / Craig B. Smith /Pergamon Press.
8. Process Heat Transfer by D.Q.Kern.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

ELECTRICAL ENERGY MANAGEMENT AND CONSERVATION

Unit-I

Induction Motors – Three Phase - Cage motors - Equivalent circuit - Speed - torque characteristics - Performance characteristics - voltage unbalance - over motoring - slip ring induction motor characteristics multi speed motors - Single Phase Induction Motors **-** Starting & running performance - Split phase - Capacitor type motors - Characteristics - Reluctance motors – Universal motors – Stepper motor – Servo motor – Characteristics - Applications

Unit-II

Energy Efficient Motors - Constructional details - Factors affecting efficiency - Losses distribution - Characteristics - Calculation of R.M.S rating - Power Factor – Causes and disadvantages of low power factor – Methods to improve p.f – Economics of power factor improvement - Simple pay back method - Return on investment - Life cycle analysis.

Unit-III

Energy efficient lighting - Terminology - Cosine law of luminance - Types of lamps - Characteristics - Design of illumination systems - Good lighting practice - Lighting control - Steps for lighting energy conservation.

Unit-IV

Economics of Electrical Energy Generation, Audit and Distribution: Definitions - Connected load, Maximum demand - Demand factor – Diversity factor – Significance - Load curve – Load sharing between base load and peak loads - Electrical Energy Audit: Check List – Data Collection – Data Analysis – Case Studies - Electrical Distribution: Electrical load analysis - types of consumers & tariffs - line losses - corona losses - types of distribution system - Kelvin's law - loss load factor.

Unit-V

Economics Of Electrical Drives - Selection of motors - types of loads - Energy Consumption during starting of a.c and d.c motors - Braking of d.c and a.c motors - Plugging - Regenerative braking – Applications of different electric drives.

Reference Books:

1. Electrical Machines /Bimbra / Khanna Publishers
2. Electrical Machinery / Fitzgerland, Kingsley, Kusko / Mc Graw Hill Ltd
3. Electrical Machines/ S.K.Bhattacharya
4. Electrical Machines /I.J.Nagarath and D.P.Kothari / TMH
5. Energy Efficient Electrical motors / John C.Andreas / Marcel Dekker Inc.
6. Electrical Technology/ Edward Hughes / ELBS.
7. Energy Management and good lighting practice: Fuel Efficiency Booklet 12 / EEO.
8. Generation, Distribution & Utilization of Electrical Energy / CL Wadhwa / Wiley Eastern Ltd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

ADVANCED CONTROL SYSTEMS

(Elective-III)

Unit-I

Classical Design techniques for linear control systems: Lag, Lead & Lag-Lead Compensation. State Space Analysis: State Space Representation, State Models, Solution of State Equation, State Transition Matrix, Canonical Forms - Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form.

Unit-II

Controllability and Observability: Tests for Controllability and Observability for Continuous Time Systems - Time Varying Case, Minimum Energy Control, Time Invariant Case, Principle of Duality, Controllability and Observability for Jordan Canonical Form and other Canonical Forms.

Unit-III

Describing Function Analysis: Introduction to nonlinear systems, Types of nonlinearities, describing functions, describing function analysis of nonlinear control systems.Phase-Plane Analysis: Introduction to phase-plane analysis. Method of Isoclines for Constructing Trajectories, Singular points.

Unit-IV

Stability Analysis: Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems, Direct method of Lyapunov for the Linear and Nonlinear continuous Time Autonomous Systems.Model Control: Effect of state feedback on controllability and observability. Design of State Feedback Controllers through Pole Placement. Full Order Observer & Reduced Order Observer.

Unit-V

Calculus of Variation: Minimization of Functional of Single Function, Constrained minimization. Minimum principle. Control Variable Inequality Constraints. Control and State Variable Inequality Constraints. Euler Lagrangine Equation.Introduction to Optimal Control: Formulation of Optimal Control Problem. Minimum Time, Minimum Energy. State Regulator Problem.

Reference Books:

1. Modern Control System Theory- by M. Gopal, New Age International Publishers, 2nd edition, 1996.
2. Modern Control Engineering - by K. Ogata, Prentice Hall of India, *3rd* edition, 1998.
3. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
4. Digital Control and State Variable Methods - by M. Gopal, Tata Mc Graw-Hill Companies, 1997.
5. Systems and Control by StainslawH. Zak, Oxford Press, 2003.
6. Modern control System - By Dorf, Pearson.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

STEAM AND GAS TURBINES*

(Elective-III)

Unit-I

Fundamentals of Turbo Machines - Classification, Applications Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiency; static and Stagnation conditions; continuity equation; Euler's flow through variable cross sectional area; unsteady flow in turbo machines.

Unit-II

Gas Dynamics - Fundamentals thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves; normal stock recovery; detached shocks

Unit-III

Steam Nozzles and Turbines: Convergent nozzles – Convergent-divergent nozzles – Energy balance – Effect of backpressure – Design aspects of nozzles - Types of steam turbines, Flow through impulse and reaction turbine stages, Impulse Turbines: Work done and stage velocity triangles; Blade and stage Efficiencies; Constant Reaction stages and Blading; Design of blade passages, angles and height; Secondary flow; leakage losses - Key elements of steam turbines.

Unit-IV

Centrifugal compressors: Elements of compressor stage, Velocity triangles and efficiencies; Blade passage design; Diffuser and pressure recovery; slip factor; Stanitz and Stodolas formulae; Compressor performance - Stall and surge, Performance characteristicsAxial Flow Compressors : Flow analysis, work and velocity triangles; Efficiencies; Thermodynamic analysis; stage pressure rise; Degree of reaction; stage loading; Free and forced vortex blades, Effect of axial velocity and incidence on velocity triangles - Performance characteristics

Unit-V

Axial Flow Gas Turbines - Work done; velocity triangles and efficiencies; thermodynamic flow analysis; degree of reaction; Zweifels relation; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disc theory; stresses in blades, Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

**** This is a descriptive course, hence numerical problems are not envisaged***

References Books:

1. Fundamentals of Turbo machines / Shephard.
2. A treatise on turbo machines - Dr G Gopalakrishna and Dr D Prithivi Raj, SCITECH Publications (India) Pvt Ltd, Chennai.
3. Theory and practice of steam turbines / Kearton.
4. Axial Turbines / Horlock.
5. Steam turbines, Theory and Design - Zoeb Husain, TMH.
6. Turbines, Compressors and Fans / Yahya.
7. Axial Flow Compressors / Horlock.
8. Gas Turbines – Theory and practice / Zucrow.
9. Elements of Gas Dynamics / Liepman and Roshkow.
10. Elements of Gas Dynamics / Yahya.
11. Gas Turbines - Dr V Ganesan, TMH.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

HYDEL POWER ENGINEERING

(Elective-III)

Unit-I

Basic Concepts: Importance of Hydro-electric power - Investigations and studies for waterpower development. Load Study and Estimation - Available power - Power duration curve - Storage and pondage - Firm power - Secondary power - Load duration curve. Power Development: Run-of-River power development -Types of plants - Mini and Micro hydel power development - Components of run-of-river power development on canal falls - Pumped Storage Power Development - Essential requirements – Necessity – Advantages - Classification of PSP development, Components – Layout – Economics - Cost of power generated.

Unit-II

Design and Construction of Hydro-Electric Works: Layout of scheme - Design of intakes - Penstocks - Economic diameters of penstocks - Design of anchor blocks - Air vents - Water hammer problems – Types of Surge tanks – Functions, Location and Types, Fore Bay - Stability of surge tanks:Principles of Hydraulic Machinery: Dynamic Force exerted by Fluid Jet on stationary Flat plate – Plate normal to jet and inclined plate - Fluid jet on curved plate - Fluid jet on moving curved surface of a turbine blade - Velocity diagrams for turbine blades - Work done on Tangential flow turbine Runner - Angular Momentum equation - Radial flow - Power produced by Radial runner.

Unit-III

Hydraulic Prime Movers-1 - History of Development of water wheel and Water Turbines - Classification of Modern Water Turbines - Impulse Turbines, Main components and their Functions - Modern Pelton turbine – Arrangements of jets – Runner - Turbine shaft - Design of components of Pelton Turbine - Force, Power and Efficiency - Velocity Triangles - Force exerted by jet - Work done and Power Developed by jet - Turbine Efficiencies.

Unit-IV

Hydraulic Prime Movers-2 - Modern Francis Turbine - Main Components – Design - Shapes of Francis Runner and Evolution of Kaplan Runner - Draft tube Theory – Cavitation – Torque - Power and Efficiencies - Propeller, Kaplan and tubular (or Bulb) Turbines – Force – Torque - Power and Efficiencies - Types of Governors, Governing of Impulse and Reaction Turbines.

Unit-V

Modeling and testing of turbines: Models and Selection of Turbines - Turbo Models and their Testing, Similarity considerations of Model and Proto type Turbines – Geometric, Kinematic and Dynamic Similarities – Performance characteristics.Power Station Planning: Power plant structure - Layout of hydro power plants - Types of power houses - Underground power houses - Investigation and studies - Safety requirements - Sizing of a power house.

References Books:

1. Fluid Mechanics And Fluid Power Engineering / D.S.Kumar.
2. Water Power Engineering / M. M. Dandekar & K. N. Sharma.
3. Fluid Power with Application / Anthony Esposito 5th Ed.
4. Hydraulic Machines/ T.R. Banga & S.C. Sharma.
5. A text Book of Water Power Engineering / R.K.Sharma & T.K.Sharma.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

SOLAR REFRIGERATION AND AIR-CONDITIONING

(Elective-III)

Unit-I

Concept of Solar Energy, review of Solar Collectors, Solar concentrators, Potential and scope of solar cooling. Types of solar cooling systems. Solar collectors and storage systems for solar refrigeration and air-conditioning.

Unit-II

Solar operation of vapor absorption and vapor compression refrigeration cycles and their thermodynamic assessment. Rankine cycle, sterling cycle based on solar cooling systems. Fuel assisted solar cooling systems,

Unit-III

Solar desiccant cooling systems Open cycle absorption / desorption solar cooling alternatives. Advanced solar cooling systems.

Unit-IV

Thermal modeling and computer simulation for continuous and intermittent solar refrigeration and air-conditioning systems Refrigerant storage for solar absorption cooling systems.

Unit-V

Solar thermoelectric refrigeration and air-conditioning. Solar thermo acoustic cooling and hybrid air-conditioning, solar economics of cooling systems.

Reference Books :

1. S.Domakundwar and S.C Arora, “A course in Refrigeration and Air- conditioning”.
2. F.Kreith and J.F Kreider, ‘Principles of Solar Engineering‘.
3. T. Nejat Vezirogulu, “Solar cooling and Heating Volumes” I, II & III.
4. A. A. M. Sayigh, J. C. McVeigh “ Solar air conditioning and refrigeration”.

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M. Tech. – I Year –II Sem (Energy Sys)

BIO CONVERSION & PROCESSING OF WASTE

(Elective-IV)

Unit-I

Biomass resources and biomass properties – biomass – definition – classification – availability – estimation of availability, consumption and surplus biomass – energy plantations. Proximate analysis, Ultimate analysis, thermo gravimetric analysis and summative analysis of biomass – briquetting.

Unit-II

Biomass pyrolysis – pyrolysis – types, slow fast – manufacture of charcoal, methods, yields and application – manufacture of pyrolytic oils and gases, yields and applications.

Unit-III

Biomass gasification – gasifiers – fixed bed system – downdraft and updraft gasifiers – fluidized bed gasifiers – design, construction and operation – gasifier burner arrangement for thermal heating – gasifier engine arrangement and electrical power – equilibrium and kinetic consideration in gasifier operation.

Unit-IV

Biomass combustion – biomass stoves – improved chullahs, types, some exotic designs – fixed bed combustors – types, inclined grate combustors – fluidized bed combustors – design, construction and operation and operation of all the above biomass combustors.

Unit-V

Introduction to Energy from waste - classification of waste as fuel – agro based, forest residue, industrial waste, MSW – conversion devices – incinerators, gasifiers, digestors

Reference books:

1. Desai, Ashok V., Non Conventional Energy, Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology - A Practical Hand Book - Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Challal, D. S., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991.
4. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

CO-GENERATION

(Elective-IV)

Unit-I

Concept of Cogeneration – review on Thermodynamics of conventional power producing plants. Selecting cogeneration technologies.

Unit-II

Thermodynamics of Cogeneration power plants – performance criteria and effect of irreversibility.

Unit-III

Comparative thermodynamic performance of cogeneration plants – performance of cogeneration plants – Numerical examples – Calculations of typical heat to power ratios and performance parameters.

Unit-IV

Design of Cogeneration plant for varying plant heat to power ratio – fuel savings from installation of cogeneration plant.

Unit-V

Economic assessment of Cogeneration schemes. Applications of cogeneration technology to various process plants.

Reference books:

1. Horlock, J. H., Cogeneration Combined Heat and Power – Thermodynamics and Performance, Pergamon Press, 1986.
2. David Hu, S., Cogeneration, Reston Publishing Co., USA, 1985.
3. Sirchis, J., Combined Production of Heat and Power, Elservier Applied Science, 1990.
4. Robert Noyes, Cogeneration of Steam and Electric Power, Noyes Data Corporation, 1986.
5. Spiewak, S. A., Cogeneration, Fairmont Press Inc., 1991.
6. Kehlhofer, R., Combined Cycle Gas and Steam Turbine Power Plants, The Fairmont Press Inc., 1991.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

GREEN BUILDINGS CONCEPTS

(Elective-IV)

Unit-I

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

Unit-II

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality - Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

Unit-III

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

Unit-IV

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

Unit-V

Energy management options - Energy audit and energy targeting - Technological options for energy management.

Reference Books:

1. J. Krieder and A. Rabl, Heating and Cooling of Buildings - Design for Efficiency, McGraw Hill, 1994.
2. S.M. Guinnes and Reynolds, Mechanical and Electrical Equipment for Buildings, Wiley, 1989.
3. A. Shaw, Energy Design for Architects, AEE Energy Books, 1991.
4. ASHRAE, Handbook of Fundamentals, Atlanta, 1997.
5. Donald W. Abrams, Low Energy Cooling – A Guide to the Practical Application of Passive Cooling and Cooling Energy Conservation Measures, Van Nostrand Reinhold Co., New York, 1986.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

COMPUTATIONAL FLUID DYNAMICS

(Elective-IV)

Unit I:

Introduction to Numerical Methods: Finite Difference, Finite Element and Finite Volume Methods – Classification of Partial Differential Equations – Solution of Linear Algebraic Equations – Direct and Iterative Approaches

Finite difference methods:- Taylor's series – FDE formulation for 1D and 2D steady state heat transfer problems – Cartesian, cylindrical and spherical co-ordinate systems – boundary conditions – Un steady state heat conduction – Errors associated with FDE - Explicit Method – Stability criteria – Implicit Method – Crank Nickolson method – 2-D FDE formulation – ADI – ADE

Unit II:

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

Unit III:

F V M to Convection and Diffusion: Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1DConvection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions

Unit IV:

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

Unit V:

Compressible Flows: Introduction – gas dynamics - Pressure, Velocity and Density Coupling.

Reference 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 & Sundarajan (Narosa Pub).
4. Computational Fluid Dynamics – Hoffman and Chiang, Engg Education System.
5. Computational Fluid Dynamics – Anderson (TMH).
6. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer).
7. Computational Fluid Dynamics, T.J. Chung, Cambridge University.
8. Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier).
9. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. – I Year –II Sem (Energy Sys)

ENERGY SYSTEMS LABORATORY

Study of

a. Operational experience on i) Pyranometer, ii) Sunshine recorder
b. Measurement of speed using Tachometer, Stroboscope and anemometers
c. Measurement of temperature using Infrared Thermometers
d. Measurement of illumination using Lux meter
e. Exhaust gas analysis using gas analyzer

List of experiments

1. Performance evaluation of a solar flat plate thermosyphon water heating system
2. Conversion efficiency of a solar flat plate forced circulation water heating system
3. Conversion efficiency of a solar Concentrating water heating system
4. Determination of conversion efficiency of a solar air heating system
5. Study and analysis of a solar still / distillation plant
6. Performance estimation of photovoltaic water pumping system
7. Investigation on a solar dryer
8. Operational characteristics of P.V. Indoor lighting system
9. Determination of characteristics of a wind generator
10. Performance evaluation of solar cooker
11. P.V.System sizing exercise
12. Data acquisition system for continuous monitoring of P.V system parameters using LABVIEW software
13. Performance estimation of Solar fuel cell