# ACADEMIC REGULATIONS (R18PG)

## COURSE STRUCTURE AND DETAILED SYLLABUS

**For**

**M.Tech.- Regular Two Year Post Graduate Degree Programe**

**(Effective from 2018-19)**

# MASTER OF TECHNOLOGY
# IN
# RENEWABLE ENERGY


**KANDULA SRINIVASA REDDY MEMORIAL COLLEGE OF ENGINEERING**

**(UGC-Autonomous)**

**Kadapa 516003, A.P**

**(Approved by AICTE, Affiliated to JNTUA, Ananthapuramu, Accredited by NAAC)**

**(An ISO 14001:2004 & 9001: 2015 Certified Institution)**

**E-mail:** principal@ksrmce.ac.in **Website:** www.ksrmce.ac.in

## KSRM COLLEGE OF ENGINEERING (AUTONOMOUS)

## VISION & MISSION

### VISION:

KSRMCE seeks to be recognized as one of the best engineering colleges in India in providing high standards of academics with most productive, creative learning environment by including research, innovation thoughts and producing graduates with human values & leadership qualities to serve nation.

### MISSION:

**M1:** To provide high quality education in Engineering & Technology in order to bring out knowledgeable engineers.

**M2:** To creative environment a collaborative environment with stakeholders to take up need-based research and industry specific programs.

**M3:** To organize co-curricular and extracurricular activities for character and personality development to produce highly competent and motivated engineers and professionals to serve and lead the society.

## DEPARTMENT OF MECHANICAL ENGINEERING

## VISION & MISSION

### VISION:

To evolve as a department of high repute in Mechanical Engineering and allied fields through effective teaching, learning process and research activities, operating with a sense of professional and social responsibility.

### MISSION:

**M1:** To produce Mechanical Engineers with sound knowledge through quality teaching-learning process and well-designed curriculum.

**M2:** To induce critical thinking attitude and inculcate the use of modern tools through inter-disciplinary research and develop entrepreneurial skills through industry-institute interaction.

**M3:** To provide opportunities/platforms for students to nurture leadership abilities and ethical values.

## PROGRAM EDUCATIONAL OBJECTIVES

**PEO1:** To apply engineering principles to develop products, processes or knowledge to solve mechanical and associated engineering problems for successful career in mechanical engineering and allied fields.

**PEO2:** To pursue higher education, research and development and engage in the process of life-long learning.

**PEO3:** To demonstrate leadership qualities, professional ethics, and communication skills and adapt current technologies to meet the societal requirements.

## PROGRAMME OUTCOMES

**Engineering Graduates will be able to:**

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

# PROGRAMME SPECIFIC OUTCOMES

**PSO 1**: To apply their knowledge in the domain of engineering mechanics, thermal andfluid sciences to solve engineering problems utilizing advanced technology.

**PSO 2:** To successfully apply the principles of design, analysis and implementationof mechanical systems/processes which have been learned as a part of the curriculum?

**PSO 3:** To Develop and implement new ideas on product design and development with thehelp of modern CAD/CAM tools, while ensuring best manufacturing practices.

**Regulations for PG Programs in Engineering (R18PG)**
**(Effective from 2018-19)**

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**KSRM College of Engineering, Kadapa-516003, AP**

**Regulations for PG Programs in Engineering (R18PG)**

## 1.0 Nomenclature

**1.1** *Academic Term*: Extent of time during which academic instructions are initiated and completed.

**1.2** *Academic Year*: Academic Term of, approximately, one year duration that usually starts in June/July and ends in April/May next

**1.3** *Semester*: Either of two Academic Terms that make up an Academic Year

**1.4** *Major*: A specific field of study

**1.5** *Minor*: An area outside of, or complementary to, a Major

**1.6** *Subject*: An area of knowledge that is studied as part of a Course

**1.7** *Core*: A subject that is mandatory for a Major course of study

**1.8** *Elective*: A subject that is selected for study to suit one's individual needs

**1.9** *Audit Subject*: A subject that is studied to meet certain requirements but has no credits assigned to it

**1.10** *Humanities subjects*: Subjects that describe and interpret human achievements, problems and historical changes at individual and societal levels covering the disciplines of literature, history, and philosophy

**1.11** *Social Sciences subjects*: Subjects that describe the mental and behavioural activities of individuals, groups, organizations, institutions, and nations covering the disciplines of anthropology, economics, linguistics, political science, and psychology

**1.12** *Exam*: A test to measure one's progress, knowledge, or ability in a subject

**1.13** *Credit*: A numerical weight given to a subject

**1.14** *Grade*: A numerical or alphabetic designation measuring the level ofachievement in an exam

**1.15** *Attendance*: Physical presence of oneself in a classroom/laboratory forpurpose of a scheduled academic instruction

**1.16** *Course*: A series of subjects that constitute a Major field of study

**1.17** *Branch*: Same as Course

**1.18** *Program*: Same as Course

**1.19** *Specialization*: Same as branch

**1.20** *Degree*: An academic title conferred to honour distinguished achievement

## 2.0 Short Title and Application

**2.1** These rules and regulations may be called as R18 PG and come into force from Academic Year 2018-19 and exist until superseded by new regulations

**2.2** These rules and regulations are applicable to all post graduate courses in engineering and technology leading to Master's Degree in Technology (M. Tech)

**2.3** The Specializations offered, at present, are:

2.3.1 Geotechnical Engineering

2.3.2 Power Systems

2.3.3 Renewable Energy
2.3.4 Embedded System & VLSI
2.3.5 Artificial Intelligence & Data Science

**2.4** The Institute may offer new Specializations in future to which these rules and regulations will be applicable

## 3.0 Suspension and Amendment of Rules

**3.1** Academic Council has the authority to suspend a rule temporarily

**3.2** Academic Council has the authority to amend a rule

**3.3** For affirmative action on any suspension or amendment of a rule, an affirmative vote of three-fifths of the members present and voting shall be required in Academic Council

## 4.0 Requirements for Admission

**4.1** At present, admissions into first semester of various Specializations are governed by Government and the Affiliating University. The eligibility criteria and procedure for admission are prescribed by Government and Affiliating University

**4.2** A student is not allowed change of Specialization after admission

**4.3** A student must fulfil medical standards required for admission

**4.4** The selected students are admitted into first semester after payment of the prescribed fees

## 5.0 Structure of the M. Tech course

**5.1** *Duration*: The duration of M. Tech degree course is four semesters

**5.2** *Working Days*: Calendar for any semester shall be announced at least four weeks before its commencement. Minimum number of working days is 90 per semester

**5.3** *Curriculum*: Each Specialization shall have core, elective and audit subjects. The curriculum for each Specialization shall be approved by its corresponding Board of Studies and then by the Academic Council

**5.4** *Credits*: All subjects that are assessed for marks have credits assigned to them. The credits assigned to subjects shall be given in curriculum. The total number of credits for entire course is 68 for all Specializations. The distribution of total credits semester-wise is given in Table 1

Table 1 Semester-wise Total Credits

| Semester | Total Credits |
|---|---|
| First Semester | 18 |
| Second Semester | 18 |
| Third Semester | 16 |
| Fourth Semester | 16 |
| **Total for entire course** | **68** |

**5.5** The curriculum and syllabus is given in Annexure-1 and Annexure-2 respectively

**5.6** Responsibility and Advising: It is the responsibility of the student to understand and know the regulations and requirements to earn the degree. Each student admitted in to the degree programs is assigned to a Faculty Advisor who assists the student in designing an effective program of study. Students should consult their Faculty Advisors for selection of electives and for general advice on academic program

## 6.0 Registration and Enrolment

**6.1** Prior to opening of each semester, every student shall register for all the credit-bearing and audit subjects listed in curriculum of the semester. Excepting first semester, the registration for a semester shall be done during a specified week after end examinations of previous semester. In first semester, the registration shall be done within six working days from date of opening. Recommendation of Faculty Advisor is needed for registration

**6.2** Late registration will be permitted with a fine, decided from time to time, up to six working days from the last date specified for registration

**6.3** A student will be eligible for registration for a semester if she or he i) is promoted to that semester, ii) has cleared all fees to the Institute, library and hostel of previous semester, and iii) is not disqualified for registration by a disciplinary action of the Institute

**6.4** A student will be enrolled and allowed to attend the classes on successful registration and payment of necessary fees to Institution, library, and hostel

**6.5** Registration and enrolment will be controlled by the Office of the Controller of Examinations.

## 7.0 Assessment Procedure – Internal Tests and End Examinations

**7.1** Performance of students in all subjects is assessed continuously through internal assessment tests and an End examination

**7.2** Allocation of internal assessment and End examination marks

7.2.1 For theory subjects, the allocation is 40 marks for internal assessment and 60 marks for End examination totalling 100 marks

7.2.2 For laboratory/project work subjects, the allocation is 50 marks for internal assessment and 50 marks for End examination totalling 100 marks

7.2.3 For mini-project/mini-project with seminar total 100 marks are allocated for internal assessment. There shall be no end examination for this mini-project

7.2.4 For all audit subjects the allocation is 40 marks for internal assessment and no allocation for End examination

**7.3** Internal Assessment Examinations

7.3.1 Internal assessment means performance evaluation of students by faculty members who teach the subjects

7.3.2 For theory subjects, including audit subjects, the internal assessment shall be done by midterm tests. For each subject, two midterm tests will be

conducted for 40 marks each and the internal assessment mark is the better of two marks. If any student abstains for any midterm test, she or he will be awarded zero marks for that midterm test. There shall be no choice of questions in midterm tests

7.3.3 For laboratory/practical subjects, the internal assessment will be based on regular laboratory work over full semester. The assessment will be done by the faculty concerned. The students shall be informed sufficiently early of the procedure to be followed for internal assessment

7.3.4 For subjects like seminar, project-work, industrial training, and comprehensive viva-voce, the internal assessment will be done by a concerned Department Committee consisting of two senior faculty members and faculty guide of concerned student. The assessment procedure will be informed sufficiently early to the students

**7.4** End examinations

7.4.1 End examinations shall be conducted after completion of coursework in each semester

7.4.2 The question papers for theory subjects shall be set by faculty members outside of the Institute. The external faculty members for question paper setting will be selected by the Principal

7.4.3 Evaluation of answer scripts shall be done by faculty members from outside of the Institute selected by the Principal

7.4.4 For laboratory subjects, end examination shall be conducted by a committee consisting of two internal examiners. One examiner shall be recommended by Head of Department of concerned Major, and the other examiner shall be appointed by the Principal

7.4.5 For project work viva-voce, End examination shall be conducted by a committee consisting of one internal examiner, one external examiner, and the concerned guide of the student. Internal examiner shall be appointed by Head of Department of concerned Major, and the external examiner shall be appointed by the Principal

7.4.6 If a student abstains from End examination of any subject, for any reason, she or he shall be awarded zero marks in that subject

7.4.7 There is no end examination for audit subjects.

## 8.0 Method of Assigning Letter Grades and Grade Points

**8.1** For all credit-bearing subjects, performance of a student in a subject is indicated by a letter grade that corresponds to absolute marks earned in that subject. Each letter grade is assigned a numeric Grade Point that is used to compute Grade Point Average on a scale of 0 to 10

**8.2** Performance of a student in both internal assessment and End examination will be considered for awarding grades for credit bearing subjects. Total marks earned in a subject is the sum of marks obtained in internal and End examinations in that subject

**8.3** Pass grade A+ to D+ is assigned to a subject based on total marks earned in that subject provided that a student earns at least i) 40% of marks in End examination marks and ii) 50% of marks in internal and End examination marks put together; otherwise fail grade F will be assigned to that subject

**8.4** Grade I will be assigned to a subject if a disciplinary action is pending and is not resolved before publication of results. Office of Controller of Examinations shall resolve the pending disciplinary action within six working days from the date of publication of results and change the grade to any of A+ to D+ or F

**8.5** Grade X will be assigned to a subject if a student abstains for End examination of that subject

**8.6** The absolute marks and corresponding letter grade and grade points are given in Table2

Table 2 Letter Grades and Grade Points

| Absolute Marks | Letter Grade | Grade Points | Remark |
|---|---|---|---|
| 95-100 | A+ | 10.0 | Pass |
| 90-94 | A | 9.5 | Pass |
| 85-89 | A- | 9.0 | Pass |
| 80-84 | B+ | 8.5 | Pass |
| 75-79 | B | 8.0 | Pass |
| 70-74 | B- | 7.5 | Pass |
| 65-69 | C+ | 7.0 | Pass |
| 60-64 | C | 6.5 | Pass |
| 55-59 | C- | 6.0 | Pass |
| 50-54 | D+ | 5.5 | Pass |
| 0-49 | F | 0.0 | Fail |
| - | I | 0.0 | Result Withheld |
| - | X | 0.0 | Absent for End Exam |

**8.7** *SGPA*: Semester Grade Point Average indicates the performance of a student in all credit-bearing subjects of a semester. SGPA is calculated as the weighted average of Grade Points of all subjects of the semester with corresponding credits of subjects as weights. Audit subjects are not considered for SGPA calculation

**8.8** *CGPA*: Cumulative Grade Point Average indicates the performance of a student in all terms up to and including the current semester under consideration. CGPA is calculated as the weighted average of SGPAs with total credits in each semester as the weights

**8.9** *Grade Card*: All students shall be issued Grade Cards after the publication of results of a semester. Grade Card is a statement of performance of a student in a semester. It contains information about each registered subject: type of subject, allocated credits, and letter grade earned. SGPA and CGPA will alsobe indicated.

## 9.0 Requirements for Completing Subjects

**9.1** A student shall complete all credit-bearing and audit subjects successfully to be eligible for award of degree

**9.2** *Credit-bearing subjects*: A student is considered to have completed a credit-bearing subject successfully and earned credits if she or he obtains a pass grade from A+ to D+ in that subject. If a student receives fail grade F or X in any subject, she or he must register for supplementary End examination for that subject as and when opportunity arises and improve grade to pass grade

**9.3** *Audit subjects*: A student is considered to have successfully completed an audit subject if she or he earns at least 40% of marks in internal assessment marks.

Supplementary exam for audit subjects: If a student fails in audit subject, she or he shall register for supplementary examination in that subject as and when the opportunity arises and pass that subject. The supplementary exam will be conducted for 40 marks covering the entire syllabus and student is deemed to have passed in the subject if she or he earns 16 marks (40% marks) in the supplementary exam, disregard of her or his performance in internal tests.

## 10.0 Requirements for taking End Examinations

**10.1** A student is eligible to take regular End Examinations of current semester ifshe or he full fills the attendance requirement

**10.2** A student shall be promoted from current semester to succeeding semesteron satisfying the attendance requirement

**10.3** A student shall complete all credit-bearing and audit subjects successfully before taking End examination for project viva-voce

**10.4** Attendance Requirement

10.4.1 Attendance of students shall be recorded for credit-bearing and audit subjects as per the workload indicated in curriculum

10.4.2 Total class-periods conducted shall be reckoned from beginning toend of a semester as published in academic calendar

10.4.3 Aggregate Percentage of Attendance is calculated using total number of class-periods attended as numerator and total number of class- periods conducted for the concerned subject as the denominator

10.4.4 A minimum aggregate attendance of 75% is required for promotion tosucceeding semester

10.4.5 A student can appeal to the Principal for condoning deficiency in aggregate attendance if she or he gets 65% or more aggregate attendance presenting a valid reason for deficiency. Such a student will be granted promotion if the Principal pardons the deficiency. Principal has the right to reject the appeal if it is not satisfied with the performance of the student or the reason cited for deficiency of the attendance

10.4.6 A student earning less than 75% aggregate attendance will be denied promotion. A student who is not promoted on basis of attendance shall be removed from the rolls and shall register for the same semester when opportunity arises. The current semester record of the student is cancelled automatically.

**10.5** A student can forgo promotion and opt to repeat the current team on written request. Recommendation of the concerned Faculty Advisor is required for cancellation of promotion. This option shall be exercised before the commencement of the End Examinations of the current term.

## 11.0 Revaluation of End Examination Scripts

**11.1** Revaluation of End Examination scripts is allowed for theory subjects only by paying requisite fee

**11.2** A Procedure for Revaluation: The script will be revaluated by an examiner appointed by the Principal. The maximum of revaluation and regular end examination marks will be awarded for that subject

**11.3** A student can apply for revaluation in a subject only once.

## 12.0 Supplementary End Examinations

**12.1** Students are eligible to take Supplementary examinations in subjects with fail grade F or X only

**12.2** Supplementary examinations for even semester subjects will be conducted with regular examinations of odd semester subjects and vice versa

**12.3** A student will be allowed to improve grade in any theory subject provided she or he has completed coursework of all semesters but before award of provisional/final degree.

## 13.0 Requirements for Award of M. Tech degree

**13.1** Time Limit for completion of requirements for award of degree is four calendar years from the date of admission. A student who could not complete all the requirements in this time limit shall forego admission and will be removed from the rolls of the Institute

**13.2** A student shall be eligible for award of degree provided she or he has:

13.2.1 Registered and successfully completed all required credit-bearing and audit subjects with a total of 68 credits

13.2.2 Secured a CGPA of 5.5 or more

13.2.3 Cleared all dues to the Institute, library and hostel

13.2.4 No disciplinary action is pending against her or him

13.2.5 Satisfied any other stipulation of the affiliating University

**13.3** Award of Class: Each student will be given class in degree based on CGPA asgiven in Table 3

Table 3 Class of Degree

| Class of Degree | Range of CGPA |
|---|---|
| Second Class | >= 5.5 but <6.5 |
| First Class | >= 6.5 but <7.5 |
| First Class with Distinction | >= 7.5 |

**13.4** Consolidated Grade Card and Degree will issued under the seal of affiliatingUniversity

## 14.0 Transitory Regulations

14.1 A student who initially joins the Institute in a previous Regulation and has to re-join in any semester of the present Regulations, due to any reason, shall be bound by the rules of the current Regulations. Board of Studies of the concerned Major will specify, extra or otherwise, academic coursework to be undertaken by such students who re-join the current Regulations.

# COURSE STRUCTURE

## SEMESTER I (R18PG)

| Course Code | Core / Elective | Course Name | L | T | P | IM | EM | CR |
|---|---|---|---|---|---|---|---|---|
| 1825101 | Core | Advanced Mathematics | 3 | 0 | 0 | 40 | 60 | 2 |
| 1899102 | Core | Advanced Thermodynamics and Fluid Mechanics | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899103 | Core | Introduction to Renewable Energy systems | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899104 | Elective 1 | Measurement and Control For Energy Systems | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899105 | | Solar Energy Technologies | | | | | | |
| 1899106 | | Power Generation, Distribution and Transmission | | | | | | |
| 1899107 | Elective 2 | Bio-Energy and Biofuels | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899108 | | Advanced Power Plant Engineering | | | | | | |
| 1899109 | | Solar Refrigeration and Air Conditioning | | | | | | |
| 1899110 | Core | Research Methodology & IPR | 2 | 0 | 0 | 40 | 60 | 2 |
| 1899111 | Core | Seminar/Industrial Visit | 0 | 0 | 4 | 40 | 60 | 2 |
| One of the Audit Courses 1870A05 | Audit Course | 1 English for Research paper writing<br>2 Disaster Management<br>3 Sanskrit for Technical Knowledge<br>4 Value Education<br>5 Constitution of India<br>6 Pedagogy Studies<br>7 Stress Management by Yoga<br>8 Personality Development through Life Enlightenment skills | 2 | 0 | 0 | 40 | | 0 |
| | | **Total** | **17** | **0** | **20** | **340** | **400** | **18** |

## SEMESTER II

| Course code | Core / Elective | Course Name | L | T | P | IM | EM | CR |
|---|---|---|---|---|---|---|---|---|
| 1899201 | Core | Energy Audit and Management | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899202 | Core | Computational Fluid Dynamics | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899203 | Elective 3 | Hydrogen and Fuel Cell Technologies | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899204 | | Wind Energy Technology | | | | | | |
| 1899205 | | Process Modeling and Simulation in Renewable Energy Systems | | | | | | |
| 1899206 | Elective 4 | Energy Storage Technology | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899207 | | Energy Conservation by Waste Heat Recovery | | | | | | |
| 1899208 | | Developing Energy Efficiency and Renewable Energy Projects | | | | | | |
| 1899209 | Core | Mini-project | 0 | 0 | 20 | 100 | 50 | 3 |
| 1899210 | Core | Energy Laboratory | 0 | 0 | 4 | 50 | 50 | 3 |
| One of the audit courses 1870A01 | Audit | 1 English for Research paper writing<br>2 Disaster Management<br>3 Sanskrit for Technical Knowledge<br>4 Value Education<br>5 Constitution of India<br>6 Pedagogy Studies<br>7 Stress Management by Yoga<br>8 Personality Development through Life Enlightenment skills. | | | | | | |
| | | **Total** | **12** | **0** | **24** | **360** | **340** | **18** |

## SEMESTER III

| Course code | Core / Elective | Course Name | L | T | P | IM | EM | CR |
|---|---|---|---|---|---|---|---|---|
| 1899301 | Elective 5 | Fuels and Combustion Technology | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899302 | | Environmental Engineering and Pollution Control | | | | | | |
| 1899303 | | Economics and Financing of Renewable Energy Systems | | | | | | |
| 1899304 | Open Elective | Renewable Energy Grid Integration | 3 | 0 | 0 | 40 | 60 | 3 |
| 1899305 | | Electric Vehicle Technology | | | | | | |
| 1899306 | | Power Electronic for Renewable Energy Systems | | | | | | |
| 1899307 | | Advanced IC Engines | | | | | | |
| 1899308 | | Biomass Characterization and Management | | | | | | |
| 1899309 | Core | Dissertation Phase-I | 0 | 0 | 20 | 100 | | 10 |
| | | **Total** | **6** | **0** | **20** | **180** | **120** | **16** |

## SEMESTER IV

| Course code | Core / Elective | Course Name | L | T | P | IM | EM | CR |
|---|---|---|---|---|---|---|---|---|
| 1899401 | Major Project | Dissertation Phase-II | 0 | 0 | 32 | 50 | 50 | 16 |
| | | **Total** | **0** | **0** | **32** | **50** | **50** | **16** |

# M.TECH.-I- SEMESTER SYLLABUS

| Course Title | ADVANCED MATHEMATICS | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899101 | BS | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 2 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | | |

**Course Objectives:**

- To equip the students with standard concepts and tools at an advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

**Course Outcomes** : On successful completion of this course, the students will be able to

| | |
|---|---|
| **CO 1** | Understand the basic knowledge on a given system of linear equations by using various methods |
| **CO 2** | Deduct various quadrature formulae. |
| **CO 3** | Apply least squares method to fit a curve. |
| **CO 4** | Solve the boundary value problems in partial differential equations. |
| **CO 5** | Solve one dimensional heat equation using Crank –Nicoleson method and wave equation by finite difference method. |

## UNIT I

**Numerical Solution of Linear System of Equations:** Solving set of equations-calculation of inverse of a matrix using Croat's method. Iterative methods - Gauss- Seidel iteration method - Relaxation method.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Solve a given system of linear equations by using various methods like Gauss-Seidal method and Relaxation method.

## UNIT II

**Numerical Integration:** Newton- Cote's quadrature formulae - Trapezoidal rule - Simpson's Rules - Romberg's method - Gaussian Quadrature formula.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Derive quadrature formulae for a function whose values are given at certain points by choosing Newton's interpolation formula for the function.
- Calculate the remainder terms in the quadrature formulae like Trapezoidal rule, Simpson's rule, Romberg's method and Gaussian quadrature.

## UNIT III

**Curve Fitting:** Method of Least squares - Fitting a straight line- a second degree parabola- an exponential curve.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Approximate functions that fit with the given data by least squares technique through a first and second degree polynomials.

## UNIT IV

**Numerical Solution of Partial Differential Equations:** Classification of partial differential equations of second order - Finite difference approximation to derivatives - Solution of Laplace equation using Guass - Seidel method.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Solve Laplace equations using Gauss - Seidel method.

## UNIT V

**Parabolic and Hyperbolic Partial Differential Equations:**

Solution of one dimensional heat equation using Crank-Nicoleson method - Solution of wave equation by finite difference method.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Solve one dimensional heat equation using Crank –Nicoleson method.
- Solve wave equation by finite difference method.

**Text Books:**

1. Introductory Methods of Numerical Analysis, SS Sastry,5th edition PHI, 2013.
2. Numerical Methods, S Arumugam A.Thangapandi Issac, A Somasundaram SCITECH Publishers, Second edition Reprint 2013.

**Reference Books:**

1. Applied Numerical Analysis, Curtis F.Gerald, Partick .o. Wheatly, Addison-Wesley,1989
2. Numerical methods for Engineers, Steven C.Chapra, Raymond P.Canale, Mc-Graw Hill company, 5th edition,2007.
3. Numerical methods in Engineering and Sciences, B.S Grewal, Khanna Publishers.

| Course Title | ADVANCED THERMODYNAMICS AND FLUID MECHANICS | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | |
| **1899102** | **CORE** | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exams** | **Total** |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| **Mid Exam Duration: 2Hours** | | | | | **End Exam Duration: 3Hours** | | | |

**Course Objectives:**

- After the completion of the syllabus students able to understanding the application of thermodynamics in real gas behavior, availability analysis, statistical and irreversible thermodynamics.
- After the completion of the syllabus students able to familiarized about the ideal and viscous fluid flow, boundary layer concepts and changes in properties in compressible flow and shock expansion..

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To develops the ability to use the thermodynamics concepts for various applications like availability analysis and thermodynamic relations. |
| **CO 2** | To analyses the real gas behavior and chemical thermodynamics. |
| **CO 3** | To achieves an understanding of the basic concepts of Statistical and Irreversible thermodynamics. |
| **CO 4** | To understands the laws of fluid flow for ideal and viscous fluids. |
| **CO 5** | To represents the real solid shapes by suitable flow patterns and to analyze the same for aerodynamics performances. |

## UNIT I

**Availability Analysis and Thermodynamic Property Relations:** Reversible work - availability - irreversibility and second – law efficiency for a closed system and steady – state control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy - internal energy and enthalpy - generalized relations for Cp and CV. Clausius Clayperon equation, Joule–Thomson coefficient. Bridgeman tables for thermodynamic relations.

## UNIT II

**Chemical Thermodynamics and Equilibrium**

Thermochemistry - First law analysis of reacting systems - Adiabatic flame temperature - entropy change of reacting systems - Second law analysis of reacting systems - Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures - evaluation of equilibrium composition.

## UNIT III

**Basic Equations of Fluid Flow and Potential Flow Theory**

Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy and their engineering applications. Rotational and irrorational flows - circulation – vorticity - stream and potential functions for standard flows and combined flows – representation of solid bodies by flow patterns. Pressure distribution over stationery and rotating cylinders in a uniform flow

**UNIT IV**

**Viscous Flow Theory**

Laminar and turbulent flow - laminar flow between parallel plates - Poiseuille's equation for flow through circular pipes. Turbulent flow - Darcy Weisbach equation for flow through circular pipe - friction factor - smooth and rough pipes - Moody diagram – losses during flow through pipes.

**UNIT V**

**Compressible Fluid Flow**

One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – fundamentals of supersonics – normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables.

**Text and Reference Books:**

1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
2. Munson B.R., Young D.F. and Okiisi, T.H., Fundamentals of Fluid Mechanics, John Wiley and Sons Inc., New York, 1990.
3. Boundary Layer Theory, H Schlichting, Ninth Edition, Springer
4. Viscous Fluid Flow, F M White, Third EditionTata McGraw Hill
5. Anderson J.D., Fundamentals of Aerodynamics, McGraw Hill, Boston, 2001.
Thermodynamics – An Engineering Approach, Cengel, Tata McGraw Hill

| Course Title | INTRODUCTION TO RENEWABLE ENERGY SYSTEMS | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | | |
| **1899103** | **CORE** | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exams** | **Total** |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| **Mid Exam Duration: 2Hours** | | | | | **End Exam Duration: 3Hours** | | | |

**Course Objectives:**

- To provide knowledge of solar energy concept and applications.
- To impart knowledge of geothermal, ocean and tidal energy and their applications.
- To understand the design of wind mills and applications.
- To understand the turbines and generators for small scale hydroelectric generation.
- To understand the important parts of a biogas plant, design and principle of bio-diesel.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To explain the basic principles of various renewable energy conversion processes and devices used therein |
| **CO 2** | To identify various parameters that influences the performance of renewable energy devices/processes |
| **CO 3** | To undertake the field projects in the area of solar thermal, solar PV, wind, biomass, ocean energy, geothermal etc |
| **CO 4** | To identify suitable renewable source and technology for a given requirement To developthe integrated renewable energy technology for decentralized power sector |

## UNIT-I

**Need of sources of renewable energy:** Introduction to different sources of renewable energy, e.g., Solar Energy, Wind Energy, Bio-mass, Geothermal Energy, Ocean energy, Solar Energy and Applications.

**Basic concepts of radiations**: Solar radiation, Direct and Indirect radiation, Radiation measuringinstrument, applications etc.

## UNIT-II

**Solar Energy:** Basics of solar thermal applications both low and high temperature ranges such as water heating, air heating, steam generation, desalination of water, crop drying and power generation, Principle of photovoltaic including introduction to various components of a photovoltaic systems for standalone/hybrid/grid connected systems

**Wind Energy:** Wind Resource assessment including instrumentation used in resource assessment, basic theory of wind, wind power generators both for decentralized applications and grid connected systems, performance characteristics, Augmentation of wind power, Betz criteria

**UNIT-III**

**Bioenergy:** Types and availability of biomass resources, various methods of biomass utilization for energy generation: gasification, briquette, palatization, syngas, Anaerobic/Aerobic digestion, ethanol and biodiesel production, types of Bio-gas digesters, Combustion characteristics of bio- gas and its different utilizations,

**Geothermal Energy:** availability and methods of utilization of geothermal resource for thermal applications and electricity generation

**UNIT-IV**

**Hydro Energy**: Basic principle of hydroelectric power generation, classification of hydropower projects (pico, micro, mini, small hydro sand large hydro projects), types of hydro turbine, various components of hydropower projects.

**Ocean Energy:** Principles utilization, thermodynamic cycles, tidal and wave energy, potential and conversion technique, Principle of ocean thermal energy conversion system.

**UNIT-V**

**Fuel Cells and Hydrogen Energy:** Introduction, principle of fuel cells, thermodynamic analysis of fuel cells, types of fuel cells, fuel cell batteries, applications of fuel cells. Hydrogen as a renewable energy source, sources of hydrogen, fuel for vehicles, hydrogen production- direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production.

**Suggested texts and reference materials**

1. Duffie, J. A., & Beckman, W. A. (2013). Solar engineering of thermal processes, fourthedition, Wiley.
2. Tiwari, G. N., & Ghosal, M. K. (2007). Fundamentals of renewable energy sources. AlphaScience International Limited.
3. Mukherjee, D., & Chakrabarti, S. (2004). Fundamentals of renewable energy systems. NewAge International.
4. Sukhatme, S. P. (2005). Solar Energy Principles of Thermal Collection and storage. TataMcGraw Hill Publishing Company Ltd. New Delhi.
5. Kothari, D. P., Singal, K. C., & Ranjan, R. (2011). Renewable energy sources and emerging technologies. PHI Learning Pvt. Ltd.

| Course Title | MEASUREMENT AND CONTROL FOR ENERGY SYSTEMS | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899104 | Elective-I | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- Students will be familiar with various measurement techniques useful for the evaluation of Energy Conservation Schemes.
- Control aspects also will be made clear to them as far as Energy Conservation Schemes are concerned.
- In short, students will become knowledgeable on the design of measurement and control systems for thermal / electrical energy systems.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understands the principle and use of sensors for measurement of different thermal and electrical parameters. |
| **CO 2** | To understand the concept of control systems, modes, design and their applications |
| **CO 3** | To understand the Control Components and Controller |
| **CO 4** | To understand the Designing of Measurement and Control Systems. |

## UNIT I

**Measurement Characteristics:** Introduction to measurements, Errors in measurements, Statistical analysis of data, Regression analysis, Correlation, Estimation of uncertainty and Presentation of data, Design of experiments– Experimental design factors and protocols.

## UNIT II

**Measurements in Energy Systems:** Basic Electrical measurements, Transducers and its types, Signal conditioning and processing - Measurement of temperature, pressure, velocity, flow rate, thermo-physical and transport properties of solids liquids and gases, Radiation properties of surfaces, Vibration and noise - Computer assisted data acquisition, Data manipulation and data presentation.

## UNIT III

**Control Systems:** Introduction, Open and closed loop control systems, Transfer function. Types of feedback and feedback control system characteristics – Effect of disturbances – Dynamic characteristics.

## UNIT IV

**Control Components and Controller:** Process characteristics, Control system parameters – DC and AC servomotors, servo amplifier, potentiometer, synchro transmitters, synchro receivers, synchro control transformer, stepper motors - continuous, discontinuous and composite control modes – Analog and Digital controllers.

## UNIT V

**Designing of Measurement And Control Systems:** Designing of temperature, pressure, flow and liquid level measurement and control system – Performance – Steady state accuracy – Transient response – Frequency response – Fault finding – Computer based controls.

### Suggested texts and reference materials


1. Alan S Morris and Reza Langari, "Measurements and Instrumentation – Theory and Application", Elsevier Inc, 2012.
2. Venkateshan. S. P, "Mechanical Measurements", Ane Books Pvt Ltd, 2010
3. Holman J.P., "Experimental methods for Engineers", McGraw – Hill, 2008.
4. Bolten. W, "Industrial Control and Instrumentation", University Press, 2004.
5. Curtis D Johnson, 'Process Control Instrumentation Technology", PHI Learning Private Limited, 2011.
6. Doblin E.O, 'Measurement System Application and Design", Second Edition, McGraw Hill, 1978.
7. Nakra, B.C., Choudhry K.K., "Instrumentation, Measurements and Analysis", Tata McGraw Hill, New Delhi, 2nd Edition 2003.

| Course Title | SOLAR ENERGY TECHNOLOGY | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899105 | Elective-I | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | | |

**Course Objectives:**

- To learn and study the radiation principles with respective solar energy estimation
- To understand PV technology principles and techniques of various solar cells / materials for energy conversion
- To learn economic and environmental merits of solar energy for variety applications.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Suggest and design solar thermal based applications. |
| **CO 2** | Designing of solar photovoltaic based power systems for both domestic and industrial applications. |
| **CO 3** | Apply the concept of utilization of solar energy for the said application in an economical way. |
| **CO 4** | To understand the Solar Passive Architecture. |

## UNIT I

**Solar Radiation and Collectors:** Solar angles – Sun path diagrams – Radiation - extra-terrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - testing methods-evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

## UNIT II

**Solar Thermal Technologies:** Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – Solar cooker : domestic, community –Solar pond – Solar drying.

## UNIT III

**Solar PV Fundamentals:** Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetro junctions - metal-semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature - efficiency measurements - high efficiency cells – Solar thermo-photovoltaic.

## UNIT IV

**Spv System Design and Applications:** Solar cell array system analysis and performance prediction-Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - centralized and decentralized SPV systems - standalone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV systems.

**UNIT V**

**Solar Passive Architecture:** Thermal comfort - bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - Radiative cooling - application of wind, water and earth for cooling; shading - paints and cavity walls for cooling - roof radiation traps - earth air-tunnel. – energy efficient landscape design - thermal comfort.

**Suggested texts and reference materials**

1. Goswami D.Y., Kreider, J. F. and Francis., "Principles of Solar Engineering', Taylor and Francis, 2000.
2. Chetan Singh Solanki, "Solar Photovoltatics – Fundamental Technologies and Applications", PHI Learning Private limited, 2011.
3. Sukhatme S.P.,. Nayak.J.P, 'Solar Energy – Principle of Thermal Storage and collection", Tata McGraw Hill, 2008.
4. Solar Energy International, "Photovoltaic – Design and Installation Manual" – New Society Publishers, 2006.
5. Roger Messenger and Jerry Vnetre, "Photovoltaic Systems Engineering", CRC Press, 2010.

| Course Title | POWER GENERATION, DISTRIBUTION & TRANSMISSION | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899106 | Elective-I | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- The subject will enhance the understanding of the students on power system dynamic stability, generation control, AC and DC transmission, and reactive power control, distribution systems along with conventional and intelligent controls.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understand the on basic principles of power Generation, Distribution & Transmission. |
| **CO 2** | To understand techniques to optimize transmission losses. |
| **CO 3** | To understand HVDC converters, advantages and economic considerations, converter control characteristics. |
| **CO 4** | To understand Distribution systems, conductor size, Kelvin's law, performance calculations and analysis. |

**UNIT I**

**Generation:** Synchronous generator operation, Power angle characteristics and the infinite bus concept, dynamic analysis and modeling of synchronous machines, Excitations systems, Prime mover governing systems, Automatic generation control;

**UNIT II**

**Auxiliaries:** Power system stabilizer, artificial intelligent controls, Power quality;

**UNIT III**

**AC Transmission:** Overhead and cables, Transmission line equations, Regulation and transmission line losses, Reactive power compensation, Flexible AC transmission;

**UNIT IV**

**HVDC transmission:** HVDC converters, advantages and economic considerations, converter control characteristics, analysis of HVDC link performance, Multi-terminal DC system, HVDC and FACTS;

**UNIT V**

**Distribution:** Distribution systems, conductor size, Kelvin's law, performance calculations and analysis, Distribution inside and commercial buildings entrance terminology, Substation and feeder circuit design considerations, distribution automation, Futuristic power generation.

**Suggested texts and reference materials**

1. Kim, C. K., Sood, V. K., Jang, G. S., Lim, S. J., & Lee, S. J. (2009). HVDC transmission:power conversion applications in power systems. John Wiley & Sons.
2. Gonen, T. (2011). Electrical power transmission system engineering: Analysis and design.CRC press.
3. Wood, A. J., Wollenberg, B. F., & Sheblé, G. B. (2013). Power generation, operation, andcontrol. John Wiley & Sons.
4. Anderson, P. M., & Fouad, A. A. (2008). Power system control and stability. John Wiley& Sons.
5. Kundur, P., Balu, N. J., & Lauby, M. G. (1994). Power system stability and control (Vol.7). New York: McGraw-hill.

| Course Title | BIO-ENERGY AND BIOFUELS | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899107 | Elective-2 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | | |

**Course Objectives:**

- This course is aimed at dissemination of important information of bioenergy to enable students to acquire knowledge on cutting-edge technologies for conversion of various biomass feedstock to bioenergy / biofuel production and their utilization in combustion engines / devices and fuel cells. On successful completion of the course, the students would be able to contribute towards providing biomass based sustainable energy solutions.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To characterize different biomass feedstock's based on its constituents and properties. |
| **CO 2** | To understand and evaluate various biomass pretreatment and processing techniques interms of their applicability for different biomass type for biomass conversion processes. |
| **CO 3** | To understand the process of combustion, pyrolysis, gasification and liquefaction for production of value added bio-products, biogas, bio-CNG generation etc. |
| **CO 4** | To understand basics of biofuels, their production technologies and applications in variousenergy utility routes. |

## UNIT I

**Biomass resource assessment:** Introduction, Classification and properties of biomass, Biomasscharacterization, different energy conversion methods, Bio Energy Resources, World Bio Energy Potential, India's Bio Energy Potential, Biomass Resources and classification, Physio-chemical characteristics. Biomass Combustion, Loose biomass densification, Biomass based power generation and utilization for domestic cooking, improved biomass cook stoves.

## UNIT II

**Biogas Systems:** Technology of Biogas production, Biogas Plants, Digester types, Digester design, Chemical kinetics and mathematical modeling of bio methanation process, Dung, Vegetable Waste and Municipal Waste based Biogas plants, Biogas as fuel for transportation, Lighting, Running Dual Fuel Engines, Electricity generation, Biogas Bottling Plant Technology, Application of Biogas slurry in agriculture, Design of Biogas for cold climates. Case studies and numerical.

## UNIT III

**Biomass Gasifiers:** History , Principle , Design of Bio mass Gasifiers , updraft gasifier, down draft gasifier, zero carbon biomass gasification plants, Gasification of plastic-rich waste, applications for cooking, electricity generation, Gasifier Engines, Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol and biogas, Biomass integrated gasification/combined cycles systems, gasification, pyrolysis,

liquification, biomass pre- treatment and processing, Case studies, biodiesel, improved biomass cookstove, bio-hydrogen generation, electricity generation from biomass gasifier, engine systems, bio-gasoline, bio-diesel and duel fuel engine, case studies.

## UNIT IV

**Biofuel:** Bioethanol production from lignocelluloses, waste material, including crop residue, sugar and starch; biodiesel production from vegetable oil and animal fat, algae; biofuel derived from; economics of biofuel production; environmental impacts of biofuels; biofuel blends; green diesel from vegetable oil; biodiesel production process, by-product utilization. Production of butanol and propanol; Production of bio-hydrogen; production of hydrogen by fermentative bacteria.

## UNIT V

**Bio-refinery concept:** Bio-refinery concept: definition; different types of bio-refinery; challenge and opportunities; Fuel and chemical production from saccharides, lingo cellulosic biomass, protein; vegetable oil; algal bio-refinery.

## Suggested texts and reference materials


1. Mutha, V. K. (2010). Handbook of bioenergy and biofuel SBS Publishers, Delhi
2. Clark, J. H., & Deswarte, F. (Eds.). (2014). Introduction to chemicals from biomass. JohnWiley & Sons.
3. Klass, D. L. (1998). Biomass for renewable energy, fuels, and chemicals. Elsevier.
4. Mukunda, H. S. (2011). Understanding clean energy and fuels from biomass. Wiley India.
5. Higman C. and Burgt M v d (2003); Gasification, Elsevier Science
6. Speight, J. (2008). Synthetic fuels handbook: properties, process and performance. McGraw-Hill
7. Dahiya, A. (Ed.). (2014). Bioenergy: Biomass to biofuels. Academic Press.
8. Hall, D. O., & Overend, R. P. (1987). Biomass: regenerable energy.
9. San Pietro, A. (Ed.). (2012). Biochemical and photosynthetic aspects of energy production.Elsevier. New York

| Course Title | ADVANCED POWER PLANT ENGINEERING | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899108 | Elective-2 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- To make the students to understand the energy scenario and the environmental issues related to the power plants.
- To create awareness to the students on the various utilities in the power plants and the avenues for optimizing them.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understanding the concept of various power plant cycles |
| **CO 2** | Possible mitigation of anthropogenic emissions by optimizing the power plant cycles/utilities |
| **CO 3** | To understand the Diesel and Gas Turbine Power Plants |
| **CO 4** | To understand the Hydroelectric & Nuclear Power Plants |

## UNIT I

**Introduction:** Overview of Indian power sector – load curves for various applications – types of power plants – merits and demerits – criteria for comparison and selection - Economics of power plants.

## UNIT II

**Steam Power Plants:** Basics of typical power plant utilities - Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system - Rankine Cycle – thermodynamic analysis. Cycle improvements – Superheat, Reheat, Regeneration

## UNIT III

**Diesel and Gas Turbine Power Plants:** I.C Engine Cycles - Otto, Diesel & Dual –Theoretical vis-à-vis actual – Typical diesel power plant – Types – Components - Layout - Performance analysis and improvement - Combustion in CI engines- E.C cycles – Gas turbine & Sterling - Gas turbine cycles – thermodynamic analysis – cycle improvements - Intercoolers, Re heaters, regenerators.

## UNIT IV

**Advanced Power Cycles:** Cogeneration systems – topping & bottoming cycles - Performance indices of cogeneration systems– Heat to power ratio - Thermodynamic performance of steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems- Binary Cycle - Combined cycle – IGCC – AFBC / PFBC cycles – Thermionic steam power plant. MHD – Open cycle and closed cycle- Hybrid MHD & steam power plants

**UNIT V**

**Hydroelectric & Nuclear Power Plants**

Hydroelectric Power plants – classifications - essential elements – pumped storage systems – micro and mini hydel power plants. General aspects of Nuclear Engineering – Components of nuclear power plants - Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor - nuclear safety – Environmental issues.

**Suggested texts and reference materials**

1. Arora and Domkundwar, A course in power Plant Engineering, Dhanpat Rai and CO, 2004.
2. Gill A.B., Power Plant Performance, Butterworths, 1984.
3. Haywood R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.
4. Horlock J.H., Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.
5. Lamarsh J.R., Introduction to Nuclear Engineering - 2nd edition, Addison-Wesley, 1983.
6. Nag P.K., Power Plant Engineering, Tata Mcgraw Hill Publishing Co Ltd, New Delhi, 1998.
7. Wood A.J., Wollenberg B.F., Power Generation, operation and control, John Wiley, New York, 1984.

| Course Title | SOLAR REFRIGERATION AND AIR CONDITIONING | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899109 | Elective-2 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | -- | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- To provide understanding of fundamental concepts of solar operated refrigeration and airconditions.
- To provide fundamental knowledge desiccant material and desiccant air conditioningsystems.
- To provide understanding of fundamental concepts the solar adsorption refrigerationsystem.
- To understand the design of solar powered absorption refrigeration system and itsapplications.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To get the knowledge of solar vapor compression and vapor absorption system |
| **CO 2** | To get the knowledge of design of adsorption refrigeration and absorption refrigeration system. |
| **CO 3** | To understand the Introduction, principle of adsorption, thermodynamics of adsorption cycles. |
| **CO 4** | To understand the Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and air-conditioning |

## UNIT I

**Introduction**: Basics of refrigeration and air conditioning, comfort zones, potential and scope of solar cooling and heating, fundamentals of conventional vapour compression system and vapour absorption system**.** Solar cooling technology: solar electrical cooling, solar thermal cooling:- open cycles (liquid and solid desiccant system), closed cycle (absorption cycle, adsorption cycle, solar radiation cooling), thermo mechanical systems, steam ejector cycle, solar combined power/cooling.

## UNIT II

**Desiccant Air Conditioning:** Desiccant materials, classification of desiccant material, fundamentals of desiccant material: adsorption process, regeneration process, adsorption rate, regeneration rate, factor affecting adsorption and regeneration of desiccant material, heating/humidification, cooling/dehumidification, desiccant dehumidifiers: desiccant bed, desiccant wheel, desiccant coated heat exchanger, solar powered desiccant air conditioning system**.**

**UNIT III**

**Adsorption Refrigeration System:** Introduction, principle of adsorption, thermodynamics of adsorption cycles: - basic adsorption cycle, heat recovery adsorption refrigeration cycle, mass recovery adsorption refrigeration cycle, thermal wave cycle, convective thermal wave cycle, intermittent adsorption systems: silica-gel/water and silica-gel methanol systems, zeolite–water systems, activated carbon–methanol systems, activated carbon–ammonia systems.

**UNIT IV**

**Absorption Refrigeration System:** Absorption cycle of operation, maximum, COP, properties of solution, aqua-ammonia solution, simple absorption system, h-x diagram, ammonia enrichment process and water -lithium bromide refrigeration system, single-effect solar absorption cycle, half-effect solar absorption cooling system, double-effect solar-assisted absorption cooling systems, diffusion absorption solar cooling system, hybrid solar absorption cooling systems.

**UNIT V**

**Potential and scope of solar cooling:** Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and airconditioning, Solar operation of vapour absorption and compression refrigeration cycles and their assessment, Solar dessicant cooling system. Open cycle absorption/desorption solar cooling alternatives, advanced solar cooling systems, refrigerant storage for solar absorption cooling systems, solar thermoelectric refrigeration and airconditioning. Economics of solar cooling

**Suggested texts and reference materials**

1. Mugnier, D., Neyer, D., & White, S. D. (Eds.). (2017). The solar cooling design guide:case studies of successful solar air conditioning design. John Wiley & Sons.
2. McVeigh, J. C., & Sayigh, A. A. M. (Eds.). (2012). Solar air conditioning and refrigeration. Newnes. Pergamon.
3. Prasad, M. (2011). Refrigeration and air conditioning. New Age International.
4. Wang, R., & Ge, T. (Eds.). (2016). Advances in solar heating and cooling. WoodheadPublishing.
5. Garg, H. P. (1987). Solar Refrigeration and Air-Conditioning. In Advances in Solar EnergyTechnology (pp. 342-442). Springer, Dordrecht.
6. Althouse, A. D., Turnquist, C. H., Bracciano, A. F., Bracciano, D. C., & Bracciano, G. M.(2004). Modern refrigeration and air conditioning. Goodheart-Willcox.

| Course Title | RESEARCH METHODOLOGY & IPR | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899110 | CORE | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | -- | 2 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- To familiarize with modeling, referencing, literature survey, etc.
- To design experiments and to analyze results of the experiments.
- To prepare technical reports and research papers.
- To prepare material for technical presentation and do oral presentation.
- To understand the purpose and terms of IPR.
- To orient to ethics in research and publication.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understand research problem formulation. |
| **CO 2** | Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. |
| **CO 3** | Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. |
| **CO 4** | Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D. |

## UNIT I

**Meaning of Research,** Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research, Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

## UNIT II

**Problem Formulation**, Understanding Modeling& Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes.

## UNIT III

**Experimental Research**: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results.

## UNIT IV

**Preparation of Dissertation** and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents.

## UNIT V

**Intellectual property rights (IPR)** - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science

## Suggested texts and reference materials


1. Borden, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach",
2. 8thEdition, McGraw-Hill, 2011
3. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age
4. International Publishers
5. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rdEdition,
6. Elsevier Inc.
7. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6th Edition July 2012

| Course Title | SEMINAR/ INDUSTRIAL VISIT | | | | M.Tech RE I Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899111 | CORE | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 0 | 0 | 4 | 2 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |
| Course Objectives: • | | | | | | | |
| Course Outcomes : On successful completion of this course, the students will be able to | | | | | | | |
| CO 1 | Students will learn to survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research. | | | | | | |
| CO 2 | Students will be able to use different experimental techniques. | | | | | | |
| CO 3 | Students will be able to use different software/ computational/analytical tools. | | | | | | |
| CO 4 | Students will be able to design and develop an experimental set up/ equipment/test rig. | | | | | | |
| CO 5 | Students will be able to conduct tests on existing set ups/equipment's and draw logical conclusions from the results after analyzing them. | | | | | | |

**Course Contents**

The Project Work will start in semester I and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

# M.TECH.-II- SEMESTER SYLLABUS

| Course Title | ENERGY AUDIT & MANAGEMENT | | | | M.Tech RE II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899201 | CORE | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- The course discusses about the energy scenario, energy conservation and its importance, energy strategy for the future, energy conservation act-2001 and its features, Kyoto protocol and global warming. The students would learn about the concepts of energy management & audit.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understand the current energy scenario along with energymanagement and strategies. |
| **CO 2** | Take action on energy conservation techniques. |
| **CO 3** | Acquire the knowledge of financial management. |
| **CO 4** | Analyze the data for energy monitoring and targeting. |

## UNIT I

**Energy Scenario**: Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment: Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features, Kyoto Protocol, Global warming.

## UNIT II

**Energy Conservation**: Introduction, Energy and heat balances, Methods for preparing process flow chart, material and energy balance in different processes, Sankey diagram, Energy conservation in boilers, Energy conservation in steam systems, Heat exchanger networking, concept of pinch, lighting systems energy efficiency study, Energy conservation opportunities; conservation in buildings, opportunities in compressed air systems, Refrigeration plants etc.

**Principles And Objectives of Energy Management**: Introduction, Energy Planning, Energy Staffing, Energy Organization, Energy Requirement, Energy Costing, Energy Budgeting, EnergyMonitoring, Energy Consciousness Energy Conversions, Energy Efficient Equipment, Energy Management Professionals, Environment Pollution due to Energy Use, Evaluation of alternative Energy Sources.

**UNIT III**

**Energy Management & Audit:** Definition, Types of energy audit, Energy management (audit) approach-understanding energy costs, Ventilation Audit, Measuring and Detection Instruments for Energy Survey, Scope of Energy audit, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.

**UNIT IV**

**Energy Action Planning**: Key elements, Force field analysis, Energy policy purpose, perspective, Contents, Formulation, Ratification, Design of Energy Management Programmes, Saving Energy and Implementation of Energy Conservation, location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability. Motivating-motivation of employees: Information system designing barriers, Strategies; Marketing and communicating-training and planning.

**Financial Management**: Investment-need, Appraisal and criteria, Financial analysis techniques, Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role ofESCOs.

**UNIT V**

**Project Management**: Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification.

**Energy Monitoring and Targeting:** Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques, energy consumption, Production, Cumulative sum of differences (CUSUM).

**Text Books:**

1. W.R Murphy & G. McKay, Energy management, Butterworth & Co ers
2. Sonal Desai, Hand Book of Energy Audit, McGraw Hill Education ( India) PrivateLimited,2018
3. Kumar, Anil, Om Prakash, Prashant Singh Chauhan, and Samsher Gautam. Energy Management: Conservation and Audits. CRC Press, 2020

**Reference Books:**

1. Loftness, Robert L. “Energy Handbook.” 2d ed. New York: Van Nostrand Reinhold Co.,
2. Turner, W. C., & Doty, S. (2013). Energy management handbook (Vol. 2). Lulu Press, Inc.
3. Kenney, W. F. Energy conservation in the process industries. Academic Press, 2012.
4. Kreith, F., & Goswami, D. Y. (Eds.). (2007). Energy Management and Conservation Handbook. CRC Press.

| Course Title | COMPUTATIONAL FLUID DYNAMICS | | | | M.Tech RE II Sem | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | | |
| **1899202** | **CORE** | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exams** | **Total** |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **Mid Exam Duration: 2Hours** | | | | | **End Exam Duration: 3Hours** | | | |
| **Course Objectives:**<br>• Student will be able to apply the concept of computational fluid dynamics in the Energy systems to predict the actual performance. | | | | | | | | |
| **Course Outcomes : On successful completion of this course, the students will be able to** | | | | | | | | |
| **CO 1** | To understands the method of modeling the flow and heat transfer phenomenon. | | | | | | | |
| **CO 2** | To develops finite difference and finite volume discretized forms of the CFD equations. | | | | | | | |
| **CO 3** | To understand the various numerical schemes to solve convection and diffusion equations. | | | | | | | |
| **CO 4** | To understand the Turbulence Models | | | | | | | |

**UNIT I**

**Introduction:** Numerical simulation – Advantages, Methods of classification of PDE's, Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions, Discretization Methods, Finite Difference Expressions from Taylor's series, Uniform and non-uniform Grids - Numerical Errors, Grid Independence Test.

**UNIT II**

**Conservation Equation:** Mass, Momentum and Energy Equation three dimensions, Eulerian and Lagrangian Approach, Equation of State, Navier's Strokes equation, Differential and Integral form of general transport equations.

**UNIT III**

**Conduction Heat Transfer:** Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems - Finite difference and Finite Volume approach.

**UNIT IV**

**Incompressible Fluid Flow:** Stream Function – Vortices methods, Finite volume methods for Convection and diffusion problem – Central difference scheme, Upwind scheme, Hybrid scheme – Assessment of each scheme - Solution algorithm for pressure – velocity – coupling in steady flows - SIMPLE Procedure of Patankar and Spalding, SIMPLER and PISO Algorithm.

**UNIT V**

**Turbulence Models:** Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

**Suggested texts and reference materials**

1. Anderson D.A., Tannehill J.I. and Pletcher R.H., "Computational fluid Mechanics and HeatTransfer, "Hemisphere Publishing Corporation, New York, USA,1984.
2. Bose T.X., "Numerical Fluid Dynamics" ,Narosa Publishing House, 1997.
3. Fletcher C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
4. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.
5. Ghoshdasdidar P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
6. Muralidhar K, and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
7. Subas V.Patankar ,"Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
8. Taylor C and Hughes J.B., "Finite Element Programming of the Navier-Stokes Equation", Pineridge Press Limited, U.K., 1981.

| Course Title | WIND ENERGY TECHNOLOGIES | | | | M.Tech RE II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899204 | Elective-3 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- Know the energy conversion techniques in wind energy
- Learn about wind turbine components and their constructions.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understand the modern wind turbine control & monitoring |
| **CO 2** | To understand the fundamentals of wind energy and its conversion system |
| **CO 3** | To learn gear coupled generator wind turbine components |
| **CO 4** | To learn modern wind turbine control & monitoring |

## UNIT I

**Wind Energy Fundamentals & Wind Measurements:** Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis.

## UNIT II

**Aerodynamics Theory & Wind Turbine Types:** Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics,Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control, Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator.

## UNIT III

**Gear Coupled Generator Wind Turbine Components And Their Construction:** Electronics Sensors/Encoder/Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronization System, Soft Starter, Switchgear[ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor/Lightning Arrestors, Oscillation & Vibration sensing.

## UNIT IV

**Direct Rotor Coupled Generator (Multipole)[Variable Speed Variable Freq.]:** Excited Rotor Synch, Generator/PMG Generator, Control Rectifier, Capacitor Banks, Step Up/Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits.

## UNIT V

**Modern Wind Turbine Control & Monitoring System:** Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.

## Suggested texts and reference materials

1. C-Wet : Wind Energy Resources Survey in India VI
2. Duffie A. and Beckmann W. A., "Solar Engineering of Thermal Processes, John Wiley,1991.
3. Freris L.L., "Wind Energy Conversion Systems", Prentice Hall, 1990.
4. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, 1996.
5. John D Sorensen and Jens N Sorensen, "Wind Energy Systems", Woodhead Publishing Ltd, 2011.
6. Kaldellis J.K., "Stand – alone and Hybrid Wind Energy Systems", CRC Press, 2010.
7. Mario Garcia –Sanz, Constantine H. Houpis, "Wind Energy Systems",CRC Press 2012.
8. Spera D.A., "Wind Turbine Technology: Fundamental concepts of Wind TurbineEngineering", ASME Press, 1994.
9. Twidell J.W. and Weir A., "Renewable Energy Sources", EFN Spon Ltd., 1983.

| Course Title | ENERGY CONSERVATION BY WASTE HEAT RECOVERY | | | | M.Tech RE II Sem | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | **Credits** | **Maximum Marks** | | |
| **1899207** | **Elective-4** | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exams** | **Total** |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **Mid Exam Duration: 2Hours** | | | | | **End Exam Duration: 3Hours** | | |

**Course Objectives:**

- The industrial sector accounts for about 40 percent of the total energy consumed in India and are responsible for around one fourth of the total greenhouse gas emissions. This share is more than half of the total GHG emissions, if energy industries are considered together. It is estimated that somewhere between 30 to 50% of industrial energy input is lost as waste heat in the form of exhaust gases, cooling water, and heat lost from equipment surfaces and heated products. As the industrial sector continues efforts to improve its energy efficiency, recovering waste heat losses provides an attractive opportunity for an emission free and less costly energy resource.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understand the on basic principles and available technologies for waste heat recovery. |
| **CO 2** | To understand industrial waste heat recovery systems. |
| **CO 3** | To understand Waste heat boilers. |
| **CO 4** | To understand the Utilization of industrial waste heat. |

**UNIT I**

**Introduction:** heat losses, its quality and quantity, potential for energy conservation. Waste heat sources: steam, compressed air, refrigeration, flue gases, furnace/air stream exhaust, high grade heat, low grade heat

**UNIT II**

**Optimal utilization of fossil fuels**: Total energy approach; Coupled cycles and combined plants;Cogeneration systems

**Energy analysis:** Utilization of industrial waste heat; Properties of exhaust gas; Gas-to- gas, gas- to-liquid heat recovery systems; Recuperates and regenerators; Shell and tube heat exchangers; Spiral tube and plate heat exchangers

**UNIT III**

**Waste heat boilers**: various types and design aspects. Heat pipes: theory and applications in waste heat recovery.

**Prime movers**: sources and uses of waste heat; Fluidized bed heat recovery systems; Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems; Thermoelectric system to recover waste heat; Heat pump for energy recovery; Heat recovery from incineration plants

**UNIT IV**

**Waste Heat Recovery calculations**: Quantifying available heat (kWh), Pinch analysis, typical energy costs/construction costs, pay back analysis, thermo-economic viability.

**UNIT V**

**Need for energy storage**: Thermal, electrical, magnetic and chemical storage systems.

**Suggested texts and reference materials**


1. Hewitt, G. F., Shires, G. L., and Bott, T. R. (1993). Process Heat Transfer, CRC Press,Florida.
2. Flynn, A. M., Akashige, T., & Theodore, L. (2019). Kern's Process Heat Transfer. JohnWiley & Sons.
3. Goswami, D. Y., and Kreith, F. (2007). Energy Conversion, CRC Press.
4. Serth, R. W., & Lestina, T. (2014). Process heat transfer: Principles, applications and rulesof thumb. Academic press.
5. Beith, R. (Ed.). (2011). Small and micro combined heat and power (CHP) systems: advanced design, performance, materials and applications. Elsevier.
6. Khanna, S., & Mohan, K. (Eds.). (1996). Wealth from waste. Tata Energy Research Institute.
7. Eriksen, V. L. (Ed.). (2017). Heat Recovery Steam Generator Technology. WoodheadPublishing.

| **Course Title** | **MINI PROJECT** | | | | | **M.Tech RE II Sem** | | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | | |
| **1899209** | **CORE** | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exams** | **Total** |
| | | 0 | 0 | 20 | 3 | 100 | - | 100 |
| **Internal Assessment** | | | | | | | | |
| **Course Objectives:**<br>• Acquire and apply new knowledge as needed, using appropriate learning strategies. | | | | | | | | |
| **Course Outcomes : On successful completion of this course, the students will be able to** | | | | | | | | |
| **CO 1** | Students will learn to survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selectedtopic of research. | | | | | | | |
| **CO 2** | Students will be able to use different experimental techniques. | | | | | | | |
| **CO 3** | Students will be able to use different software/ computational/analytical tools. | | | | | | | |
| **CO 4** | Students will be able to design and develop an experimental set up/equipment/test rig. | | | | | | | |
| **CO 5** | Students will be able to conduct tests on existing set ups/equipment and drawlogical conclusions from the results after analyzing them. | | | | | | | |

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferablybring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

| Course Title | RENEWABLE ENERGY LAB | | | | M.Tech RE II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899210 | CORE | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 0 | 0 | 4 | 3 | 50 | 50 | 100 |
| | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- The main focus of this laboratory is to provide exposure and hands-on-skills practice to the students on various aspects of renewable energy sources and technology. The students would be able to get detailed insights into the design and operational aspects of renewable energy devices and systems.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To impart knowledge on fundamentals of economic principles and their applications in the broad field of supply and demand of energy. |
| **CO 2** | To make students inquisitive about the problems of energy economics and arousing their interest on practical problem solving skills. |
| **CO 3** | To understand the CI engine performance using Diesel fuel, Engine performance analysis using synthesis gas. |
| **CO 4** | To understand the Experimental study on thermal performance and efficiency of biomass. |

## UNIT I

**Preparation for Laboratory Experiments and report writing Basic concepts:** Terminology used in experimental methods i.e. sensitivity, accuracy, uncertainty, calibration and standards; experimental system design and arrangement. Analysis of experimental data, Analysis of causes and types of experimental errors, uncertainty and statistical analysis of experimental data; Error analysis, Technical Communication: Report preparation of experimental work, use of graphs, figures, tables, software and hardware aids for technical communication.

## UNIT II

**Experiments:**

**Solar:** Experimental study on thermal performance of solar water heater, solar dryers, solar cooker; solar thermal; solar PV module characterization with different configuration

**Biomass:** Experimental study on thermal performance and efficiency of biomass downdraft gasifier and sampling and analysis of air and flue gas from biomass energy systems i.e. gasifier, combustor and cook stoves using gas chromatography technique; Liquid bio-fuel production and characterization; Biogas production by anaerobic digestion and analysis.

**Wind**: Experimental study on Wind Energy Training System, Wind Turbine Emulator etc for power generation and energy assessment due to wind.

**Fuel:** Density, Viscosity, Flash-point, Fire-point Pour-point, ASTM distillation of liquid fuels; Proximate and Ultimate analysis, calorific value of solid fuels

**UNIT III**

**Engine performance analysis:** CI engine performance using Diesel fuel, Engine performance analysis using synthesis gas

**UNIT IV**

**Instrumentation and control:** Use of microprocessor kit, microcontroller, data acquisition and display experiments, performance evaluation of renewable energy systems (solar thermal, solar PV, Wind turbine, biomass gasifier) using microprocessor/microcontroller based data acquisitionsystems

**UNIT V**

**Energy system Simulation:** Photovoltaic system performance analysis using simulation tool; Hybrid energy systems using simulation tool; Building design and thermal performance analysis using simulation tool

**Suggested texts and reference materials**

Necessary laboratory instruction related to lab experiment and brochure will be provided by the lab instructor.

# M.TECH.-III- SEMESTER SYLLABUS

| Course Title | FUELS AND COMBUSTION TECHNOLOGY | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899301 | Elective-5 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- To impart knowledge on fossil fuel and their combustion characteristics.
- To make students inquisitive about the problems of combustion.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understand the fuel combustion process. |
| **CO 2** | Apply fundamental aspects of combustion related problem and an understanding on the combustion appliances. |
| **CO 3** | To understand the Petroleum as a source of energy. |
| **CO 4** | To understand the Emissions from fuel combustion systems. |

**UNIT-I**

**Basics of fuels:** Modern concepts of fuel, Solid, liquid and gaseous fuels, composition, basic understanding of various properties of solid fuels - heating value, ultimate analysis, proximate analysis, ash deformation points; liquid fuels - heating value, density, specific gravity, viscosity, flash point, ignition point (self, forced), pour point, ash composition and gaseous fuels.

**UNIT-II**

**Coal as a source of energy:** Coal reserves – World and India, Coal liquefaction process, various types of coal and their properties, Origin of coal, composition of coal, analysis and properties of coal, Action of heat on coal, caking and coking properties of coal; Processing of coal: Coal preparations, briquetting, carbonization, gasification and liquefaction of coal, Coal derived chemicals.

**UNIT-III**

**Petroleum as a source of energy:** Origin, composition, classification of petroleum, grading of petroleum; Processing of petroleum: Distillation of crude petroleum, petroleum products, purification of petroleum products – thermal processes, catalytic processes, specifications and characteristics of petroleum products.

**Natural gas and its derivatives:** Classification of gaseous fuels – natural gas and synthetic gases, Natural gas reserves - World and India, properties of natural gas – heating value, composition and density

**UNIT-IV**

**Principles of combustion:** Chemistry and Stoichiometric calculation, thermodynamic analysis and concept of adiabatic flame temperature; Combustion appliances for solid, liquid and gaseous fuels: working, design principles and performance analysis.

**UNIT-V**

**Emissions from fuel combustion systems:** Pollutants and their generation, allowed emissions, strategies for emission reduction, Euro and BIS norms for emission, recent protocols.

**Suggested texts and reference materials**

1. Raghavan, V. (2016). Combustion technology: essentials of flames and burners. John Wiley & Sons.
2. Sharma, S. P., & Mohan, C. (1984). Fuels and combustion. Tata McGraw Hill
3. Sarkar, S. (1974). Fuels and combustion. Universities Press. Orient Longman
4. Sharma, B. K. (1998). Fuels and Petroleum Processing. Krishna Prakashan Media.
5. Hsu, C. S., & Robinson, P. R. (Eds.). (2017). Springer handbook of petroleum technology.Springer.
6. Zheng, C., & Liu, Z. (Eds.). (2017). Oxy-fuel Combustion: Fundamentals, Theory and Practice. Academic Press.
7. Maurya, R. K., Maurya, R. K., & Luby. (2018). Characteristics and control of low temperature combustion engines. Springer.

| Course Title | ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899302 | Elective-5 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- On successful Completion of this course the student will be understand Emission standards, waste management power generation and pollution from various industries.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To imparts knowledge on the atmosphere and its present condition, global warming and eco-legislations. |
| **CO 2** | To detail on the sources of air, water and noise pollution and possible solutions for mitigatingtheir degradation. |
| **CO 3** | To elaborates on the technologies available for generating energy from waste. |
| **CO 4** | To analyze waste management. |

## UNIT I

**Introduction:** Global atmospheric change – greenhouse effect – Ozone depletion - natural cycles - mass andenergy transfer — material balance — environmental chemistry and biology — impacts — environmental. Legislations.

## UNIT II

**Air Pollution:** Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor airquality - control methods and equipments - issues in air pollution control – air sampling and measurement.

## UNIT III

**Water Pollution:** Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

## UNIT IV

**Waste Management:** Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

## UNIT V

**Other Types of Pollution From Industries:** Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control — environment impact assessment for various projects — case studies. Radiation pollution: types, sources, effects, control of radiation pollution.

## Suggested texts and reference materials

1. Arcadio P Sincero and G.A. Sincero, Environmental Engineering — A Design Apporach, Prentice Hall of India Pvt. Ltd, New Delhi, 2002.
2. Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore, 2000.
3. G. Masters, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt. Ltd, New Delhi, 2003.
4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 1998.
5. H.Ludwig, W. Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands N.J. (1991).
6. H.S. Peavy, D.R. Rowe and G. Tchobanoglous, Environmental Engineering McGraw- Hill Book Company, NewYork, (1985).
7. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age InternationalPublishers, 2006.

| Course Title | ECONOMICS AND FINANCING OF RENEWABLE ENERGY SYSTEMS | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899303 | Elective-5 | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- Economics of energy and its financing is a broad scientific area which includes topics related to economic aspects of supply and use of energy in society in general and the nation as a whole for its growth and development needs. Hence, it is very important for the students to understand the basics of economic principles that govern the supply and demand of energy in the context of modern civilization. This course aims at bridging the technological aspects of energy resources to that of its economic principles.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To impart knowledge on fundamentals of economic principles and their applications in the broad field of supply and demand of energy. |
| **CO 2** | To make students inquisitive about the problems of energy economics and arousing their interest on practical problem solving skills. |
| **CO 3** | To understand the Concepts of economic attributes. |
| **CO 4** | To understand the Application of econometrics. |

## UNIT I

**Energy economics:** Basic concepts, energy data, energy cost, energy balance. Relevance of economic and financial viability evaluation of renewable energy technologies, Basics of engineering economics.

## UNIT II

**Energy accounting framework:** Economic theory of demand, production and cost market structure; National energy map of India, Energy subsidy – National and international perspectives.

## UNIT III

**Concepts of economic attributes:** Calculation of unit cost of power generation from different sources with examples, different models and methods, Social cost – benefit analysis of renewable energy technologies. Financial feasibility evaluation of renewable energy technologies, Technology dissemination models, Volume and learning effects on costs of renewable energy systems, Dynamics of fuel substitution by renewable energy systems and quantification of benefits.

**UNIT IV**

**Application of econometrics**: input and output optimization; energy planning and forecasting - different methods, Economic approach to environmental protection and management,

**UNIT V**

**Financial incentives:** Fiscal, financial and other incentives for promotion of renewable energy systems and their effect on financial and economic viability, electricity tariff types. Financing of renewable energy systems, Carbon finance potential of renewable energy technologies and impact of other incentives. Software for financial evaluation of renewable energy systems.

Casestudies on financial and economic feasibility evaluation of renewable energy projects.

**Suggested texts and reference materials**


1. Campbell, H. F., & Brown, R. P. (2003). Benefit-cost analysis: financial and economicappraisal using spreadsheets. Cambridge University Press.
2. Kandpal, T. C., & Garg, H. P. (2003). Financial evaluation of renewable energy technologies. MacMillam India Limited.
3. Park, C. S. (2002). Contemporary engineering economics (Vol. 4). Upper Saddle River,NJ: Prentice Hall.
4. Kroemer, K. H., Kroemer, H. B., & Kroemer-Elbert, K. E. (2001). Ergonomics: how todesign for ease and efficiency. Pearson College Division.
5. Dorsman, A. B., Ediger, V. Ş., & Karan, M. B. (Eds.). (2018). Energy Economy, Financeand Geostrategy. Springer.
6. Banks, F. E. (2012). Energy economics: a modern introduction. Springer Science & Business Media.
7. Thuesen G. J. and Fabrycky W. J. (2001); Engineering Economy, Ninth Edition, PrenticeHall India

| Course Title | RENEWABLE ENERGY GRID INTEGRATION | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899304 | Open Elective | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

The generation of electricity from renewable energy sources includes technologies such as hydropower, wind power, solar power, tidal and wave power, geothermal power, and power fromrenewable biomass. These sources are termed as distributed power generators and they need to be integrated among themselves and with the conventional power grid for storage and uninterrupted power flow. Grid integration is an important aspect of renewable energy engineering and needs to be formally studied.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understand the distributed generation systems, to identify emerging issues with it, and thus understand the requirements for the correct integration of renewable energies into the powergrid. |
| **CO 2** | To understand power electronic components necessary for integration to include inverters and their control, island detection systems, and maximum power point tracking. |
| **CO 3** | To understand the Power control and management systems |
| **CO 4** | To understand the Simulation of grid connected/off grid renewable energy system. |

## UNIT I

**Power system operation:** Introduction on electric grid, Supply guarantees, power quality and Stability, Introduction to renewable energy grid integration, concept of mini/micro grids and smart grids; Wind, Solar, Biomass power generation profiles, generation electric features, Load scheduling

## UNIT II

**Power electronic systems:** Introduction to basic analysis and operation techniques on power electronic systems; Functional analysis of power converters, Power conversion schemes between electric machines and the grid, Power systems control using power converters; Electronic conversion systems application to renewable energy generation systems, Basic schemes and functional advantages; Wind Power and Photovoltaic Power applications

## UNIT III

**Power control and management systems:** Grid integration, island detection systems, synchronizing with the grid; Issues in integration of converter based sources; Network voltage management; Power quality management and Frequency management; Influence of PV/WECS on system transient response

**UNIT IV**

**Simulation**: tools, Simulation of grid connected/off grid renewable energy system (PV/WECS); Design of grid-interactive photovoltaic systems for house hold applications.

**Suggested texts and reference materials**

1. Kersting W. H. (2004). Distribution System Modeling and Analysis, Second Edition, CRCPress
2. Vittal V. and Ayyanar R. (2012). Grid Integration and Dynamic Impact of Wind Energy,Springer
3. Bollen M. H. and Hassan F. (2011). Integration of Distributed Generation in the PowerSystem, Wiley-IEEE Press
4. Keyhani A. (2011). Design of Smart Power Grid Renewable Energy Systems, Wiley–IEEEPress
5. Muhannad H. R. (2004). Power Electronics: Circuits, Devices and Applications, PearsonPrentice Hall
6. Gellings C. W. (2009). The Smart Grid: Enabling Energy Efficiency and Demand Response, First Edition, CRC Press
7. Teodorescu R. Liserre M. Rodriguez P. (2011). Grid Converters for Photovoltaic and WindPower Systems, First Edition, Wiley-IEEE Press

| Course Title | ELECTRIC VEHICLE TECHNOLOGY | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899305 | Open Elective | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- The objective of this course is to provide an advanced level understanding on electric vehicles and batteries that are used in such vehicles. The course will impart knowledge on the fundamental electrochemistry of battery systems, design of electric vehicle, business model, policy, impact etc.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To get the knowledge of electric vehicles and batteries systems. |
| **CO 2** | To get the knowledge of design of electric vehicle, business model, policy, impact etc. |
| **CO 3** | To understand the Energy Storage Requirements. |
| **CO 4** | To understand Fundamental of Rechargeable batteries. |

**UNIT I**

**Review of Conventional Vehicle:** Introduction to Hybrid Electric Vehicles: Types of EVs, Hybrid Electric Drive-train, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains

**UNIT II**

**Architecture of Hybrid Electric:** Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor

**UNIT III**

**Sizing the drive system**: Design of Hybrid Electric Vehicle and Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H.

**UNIT IV**

**Energy Storage Requirements**:- Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

## UNIT V

**Fundamental of Rechargeable batteries:** Electrochemistry, Lithium batteries, Nickel metal hydride battery, Lead-acid battery, High temperature batteries for back-up applications, Flow batteries for load leveling and large scale grid application, Battery applications for stationary and secondary use, Battery chargers and battery testing procedures, Battery management, Regulations and safety aspects of high voltage batteries, Super capacitors.

**Business**: E-mobility business, electrification challenges, Business- E-mobility business, electrification challenges, Connected Mobility and Autonomous Mobility- case study E-mobility Indian Roadmap Perspective.

**Policy:** EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs.Simulations and case studies in above mentioned areas.

**Suggested texts and reference materials**


1. Emadi, A. (Ed.). (2014). Advanced electric drive vehicles. CRC Press.
2. Larminie, J., & Lowry, J. (2012). Electric vehicle technology explained. John Wiley &Sons.
3. Fenton, J., & Hodkinson, R. (2001). Lightweight electric/hybrid vehicle design. Elsevier.
4. Dincer, I., Hamut, H. S., & Javani, N. (2016). Thermal management of electric vehiclebattery systems. John Wiley & Sons.
5. Williamson, S. S. (2013). Energy management strategies for electric and plug-in hybridelectric vehicles. New York, NY: Springer.
6. Pistoia, G., & Liaw, B. (Eds.). (2018). Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer.
7. Reddy, T. B. (2011). Linden's handbook of batteries (Vol. 4). New York: Mcgraw-hill.
8. Larminie, J., & Lowry, J. (2012). Electric vehicle technology explained. John Wiley &Sons.

| Course Title | POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899306 | Open Elective | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters forrenewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solarenergy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters forrenewable energy systems.
- To develop maximum power point tracking algorithms.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | After completion of syllabus student able to develop maximum power point tracking algorithms. |
| **CO 2** | Understand the Knowledge in power converters namely AC to DC, DC to DC and AC to AC converters forrenewable energy systems. |
| **CO 3** | To understand Analysis of Wind and PV Systems. |
| **CO 4** | To understand the Hybrid Renewable Energy Systems. |

## UNIT-I

**Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems: operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

## UNIT-II

**Electrical Machines for Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG andDFIG.

## UNIT-III

**Power Converters:** Solar: Block diagram of solar photo voltaic system: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing. Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

## UNIT-IV

**Analysis of Wind And PV Systems:** Standalone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system.

## UNIT-V

**Hybrid Renewable Energy Systems:** Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV- Maximum Power Point Tracking (MPPT).

## Suggested texts and reference materials

1. Bhadra.S.N, Kastha.D , and Banerjee.S, “Wind Electrical Systems”, Oxford University Press, 2009.
2. Gray L. Johnson, “Wind energy system”, Prentice hall linc, 1995.
3. Khan.B.H, “Non-conventional Energy sources”, Tata McGraw-hill Publishing Company, NewDelhi.
4. Mukund.R.Patel," Wind and Solar Power Systems", 2nd Edition, Taylor and Francies, 2001.
5. Rashid M. H “Power electronics Hand book”, Academic press, 2001.
6. Rai G.D., “Non-conventional energy sources”, Khanna publishers, 1993.
7. Rai G.D., “Solar energy utilization”, Khanna publishers, 1993.
8. Roger A. Messenger, Jerry Ventre," Photovoltaic System Engineering", CRC Press, 2004.

| Course Title | ADVANCED INTERNAL COMBUSTION ENGINES | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1899307 | Open Elective | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

- To gain insight on the working principle of spark ignition engines and compression ignitionengines.
- To study the pollutant formation and its control in IC engines.
- To study the recent technologies adopted in IC engine applications.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understand the workingprinciple of IC engines, source of pollution formation and its control and recent trends in IC engines |
| **CO 2** | To understand the Compression Ignition Engines |
| **CO 3** | To understand the Pollutant Formation and Control |
| **CO 4** | To understand the Recent Trends |

**UNIT I**

**SPARK IGNITION ENGINES:** Spark ignition Engine mixture requirements – Fuel – Injection systems – Mono point, Multipointinjection, Direct injection – Stages of combustion – Normal and abnormal combustion – factorsaffecting knock – Combustion chambers.

**UNIT II**

**COMPRESSION IGNITION ENGINES:** States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – spray structure, spray penetration and evaporation – air motion – Introduction to Turbo charging.

**UNIT III**

**POLLUTANT FORMATION AND CONTROL:** Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

**UNIT IV**

**ALTERNATIVE FUELS:** Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits andDemerits as fuels, Engine Modifications.

**UNIT V**

**RECENT TRENDS:** Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry, and Nano technology in IC Engines.

**Suggested texts and reference materials**


1. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company, Inc., 1989.
2. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
3. K.K. Ramalingam, Internal Combustion Engine fundamentals, Scitech Publications, 2002.
4. Kirpal Singh, Automobile Engineering Vol - I, Standard Publishers, Delhi 2013.
5. R.B. Mathur and R.P. Sharma, Internal Combustion Engines, Dhanapat Rai Publications, 1993.
6. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw-Hill Education, 2002.
7. Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 1997.

| Course Title | BIOMASS CHARACTERIZATION AND MANAGEMENT | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899308 | Open Elective | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| Mid Exam Duration: 2Hours | | | | | End Exam Duration: 3Hours | | |

**Course Objectives:**

There is an immense prospect in the biomass feedstock's to address the growing energy demands. However biomass recalcitrant that is not easy to break into simple sugars and varied physio- chemical attributes of biomass that is biomass growing at different regions, seasons and field conditions showing varied physio-chemical properties impede the biomass energy conversion process largely. Overall, this course provides overall information on concepts, tools and techniques for converting the different biomass into various energy forms for starting the biomass based energy production and its management.

**Course Outcomes : On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | To understand the on basics of biomass resources and it composition. |
| **CO 2** | To understand biomass sample preparation, methods of pre-treatments and characterization. |
| **CO 3** | To understand and analyze the biochemical and ultimate properties of biomass. |
| **CO 4** | To understand supply chain methods of biomass management. |

## UNIT I

**Introduction:** properties of biomass, different energy conversion methods combustion, Bio Energy Resources, World Bio Energy Potential, India's Bio Energy Potential, Biomass Resources and classification, Physio - chemical characteristics.

**Biomass Cookstoves:** Energy Systems Energy Efficient Wood Stoves**,** Traditional Stoves, Energy Efficient Cooking and Space heating Stoves, Metal Stoves Improved Gasifier Stoves , Current Research Status, Pollution due to smoke emissions, Improved Cookstoves, National Policy on cookstove.

## UNIT II

**Characterization of biomass feedstock:** physico-chemical properties, ultimate, proximate, compositional, calorific value, thermogravimetric, differential thermal and ash fusion temperature analyses; classification of biomass feedstock.

## UNIT III

**Application of biomass fuel:** Biomass based incineration plant for heat generation; co-firing of biomass for heat generation for industrial processes; Biomass fuelled combustion devices for cooking and heating applications; Utilization of biomass in external combustion engines including steam turbine power plant and Sterling engines; Case studies for setting up biomass based small power plant (~ 1MW) capacity for rural electrification; analysis of carbon neutral and carbon credit.

## UNIT IV

**Biomass Management:** Introduction to biomass management, biomass resource assessment management techniques/supply chains, Processing of paddy straw, densification-Extrusion process, pellets, mills and cubers, Bailing-classification, uses; residue management for surface mulch and soil incorporation, Paddy Straw choppers and spreaders as an attachment to combine Harvester, Mulch seeder, Paddy Straw Chopper-cum-Loader, Balar for collection of straw; Processing of straw/ fodder for animal use; Agricultural and horticultural use, Cushioning material for fruits and vegetables, Mulching and Composting, Paper and cardboard manufacturing, Straw as a fuel.

## UNIT V

**Biomass resource assessment management techniques/supply chains:** Elements of an Assessment or Feasibility Study , Objectives of biomass resource assessment, Biomass resource from agricultural and residues, Biomass resource from forestry, Biomass resource from live stock (animals), Technologies available for the conversion of biomass, Techno-economic feasibility of suitable renewable energy generation system

## Suggested texts and reference materials


1. Cheng, J. (Ed.). (2017). Biomass to renewable energy processes. CRC press.
2. Strezov, V., & Anawar, H. M. (Eds.). (2018). Renewable Energy Systems from Biomass: Efficiency, Innovation and Sustainability. Crc Press.
3. Holm-Nielsen, J., & Ehimen, E. A. (Eds.). (2016). Biomass supply chains for bioenergy and biorefining. Woodhead Publishing.
4. Jeguirim, M., & Limousy, L. (Eds.). (2019). Char and Carbon Materials Derived from Biomass: Production, Characterization and Applications. Elsevier.
5. Mukunda, H. S. (2011). Understanding clean energy and fuels from biomass. Wiley India.
6. Tumuluru, J. S. (Ed.). (2018). Biomass preprocessing and pretreatments for production of biofuels: mechanical, chemical and thermal methods. CRC Press.
7. Dayton, D. C., & Foust, T. D. (2019). Analytical Methods for Biomass Characterizationand Conversion. Elsevier.

| Course Title | DISSERTATION PHASE-I | | | | M.Tech RE III Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899309 | CORE | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 0 | 0 | 20 | 10 | 100 | - | 100 |
| **Internal Assessment** | | | | | | | | |
| **Course Objectives:** | | | | | | | | |
| **Course Outcomes : On successful completion of this course, the students will be able to** | | | | | | | | |
| **CO 1** | Students will learn to survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selectedtopic of research. | | | | | | | |
| **CO 2** | Students will be able to use different experimental techniques. | | | | | | | |
| **CO 3** | Students will be able to use different software/ computational/analytical tools. | | | | | | | |
| **CO 4** | Students will be able to design and develop an experimental set up/equipment/test rig. | | | | | | | |
| **CO 5** | Students will be able to conduct tests on existing set ups/equipment's and drawlogical conclusions from the results after analyzing them | | | | | | | |

**Course Contents**

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

# M.TECH.-IV- SEMESTER SYLLABUS

| Course Title | DISSERTATION PHASE-II | | | | M.Tech RE IV Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1899401 | CORE | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 0 | 0 | 32 | 16 | 50 | 50 | 100 |
| **Internal Assessment** | | | | | | | | |
| **Course Objectives:** | | | | | | | | |
| **Course Outcomes : On successful completion of this course, the students will be able to** | | | | | | | | |
| **CO 1** | Students will develop attitude of lifelong learning and will develop interpersonalskills to deal with people working in diversified field will. | | | | | | | |
| **CO 2** | Students will learn to write technical reports and research papers to publish atnational and international level. | | | | | | | |
| **CO 3** | Students will develop strong communication skills to defend their work in front of technically qualified audience. | | | | | | | |

**Course Contents**

It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. . The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.

# AUDIT COURSE-I & II SYLLABUS

| Course Title | ENGLISH FOR RESEARCH PAPER WRITING (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1870A01 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understand Writing skills and level of Readability. |
| **CO 2** | Analyze what to write in each section. |

**UNIT I**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

**UNIT II**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

**UNIT III**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

**UNIT IV**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

**UNIT V**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**Text Books:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

**Reference Books:**

1. Adrian Wallwork, English for Academic Research: Grammar Usage and Style, Springer.

| Course Title | DISASTER MANAGEMENT (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | Credits | Maximum Marks | | |
| 1870A02 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understand foundations of hazard, disasters and natural/social phenomena. |
| **CO 2** | Analyze Repercussions of disasters and hazards. |
| **CO 3** | Understand key concepts in disaster risk reduction and humanitarian response. |

**UNIT I**

**Introduction to Disaster:** Definition, Factors and Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

**UNIT II**

**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**UNIT III**

**Disaster Prone Areas In India**

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

**UNIT IV**

**Disaster Preparedness and Management**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

**UNIT V**

**Risk Assessment**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People'sParticipation In Risk Assessment. Strategies for Survival.

**Disaster Mitigation**

Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

**Text Books:**

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

**Reference Books:**

1. Fundamentals of Disaster Management, Shekhawat R.S, Bhatnagar Harshul.
2. Disaster management, Ruthra, Lakshmi Publications.
3. Disaster Management and Preparedness, Nidhi Gauba Dhawan, Ambrina Sardar Khan, CBS Publishers.

| Course Title | SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours/Week** | | | **Credits** | **Maximum Marks** | |
| **1870A03** | **Audit Course** | **L** | **T** | **P** | **C** | **Continuous Internal Assessment** | **End Exams** | **Total** |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| **Mid Exam Duration: 2 Hours** | | | | | | | | |

**Course Objectives:**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning.
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Understand Sanskrit grammar and Composition. |
| **CO 2** | Understand roots of technical information about Sanskrit literature. |
| **CO 3** | Understand Technical concepts of Engineering. |

**UNIT I**

Alphabets in Sanskrit,
Past/Present/Future Tense,
Simple Sentences

**UNIT III**

Order
Introduction of roots
Technical information about Sanskrit Literature

**UNIT III**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

**Text Books:**

1. Dr.Vishwas, "Abhyaspustakam" – Samskrita-Bharti Publication, New Delhi.

2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

3. Suresh Soni , "India's Glorious Scientific Tradition", Ocean books (P) Ltd., New Delhi.

| Course Title | VALUE EDUCATION (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1870A04 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Knowledge of self-development |
| **CO 2** | Learn the importance of Human values |
| **CO 3** | Developing the overall personality |

**UNIT I**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.

Moral and non- moral valuation. Standards and principles. Value judgements

**UNIT II**

Importance of cultivation of values.

Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.

Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**UNIT III**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.

Punctuality, Love and Kindness.

Avoid fault Thinking.

Free from anger, Dignity of labour.

Universal brotherhood and religious tolerance.

True friendship.

Happiness Vs suffering, love for truth.

Aware of self-destructive habits.

Association and Cooperation.

Doing best for saving nature

**UNIT IV**

Character and Competence –Holy books vs Blind faith.
Self-management and Good health.
Science of reincarnation.
Equality, Nonviolence ,Humility, Role of Women.
All religions and same message.
Mind your Mind, Self-control.
Honesty, Studying effectively

**Text Books:**

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.
2. John Haffai, Lead on & How to win over worry, World Book Publisher.
3. Swami Vivekananda, Call to the Youth for Nation Building, Advaita Ashrama, Calcutta.
4. Swami Vivekananda, Youth and Modern India, Rama Krishna Mission, Chennai.

**Reference Books:**

1. M.G. Chitakra, Education and Human values, A.P.H. Publishing corporation, New Delhi.

| Course Title | CONSTITUTION OF INDIA (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1870A05 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik
- Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Discuss the growth of the demand for civil right s in India for the bulk of Indians before the arrival of Gandhi in Indian politics |
| **CO 2** | Discuss the intellectual origins of the frame work of argument that informed the conceptualization of sociall reforms leading to revolution in India |
| **CO 3** | scuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. |
| **CO 4** | scuss the passage of the Hindu Code Bill of 1956 |

**UNIT I**

**History of Making of the Indian Constitution:**

History, Drafting Committee, (Composition & Working)

**Philosophy of the Indian Constitution:**

Preamble, Salient Features

**UNIT II**

**Contours of Constitutional Rights & Duties:**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT III**

**Organs of Governance:**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions

**Executive:**

President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT IV**

**Local Administration:**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

**Pachayati raj:** Introduction, PRI: Zila Pachayat.

Elected officials and their roles, CEO Zila Pachayat: Position and role.

**Block level:** Organizational Hierarchy (Different departments),

**Village level:** Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT V**

**Election Commission:**

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners.

**State Election Commission:** Role and Functioning.

Institute and Bodies for the welfare of SC/ST/OBC and women.

**Text Books:**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

| Course Title | PEDAGOGY STUDIES (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1870A06 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries? |
| **CO 2** | What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? |
| **CO 3** | How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? |

**UNIT I**

**Introduction andMethodology:**

Aims and rationale, Policy background, Conceptual framework and terminology
Theories of learning, Curriculum, Teacher education.
Conceptual framework, Research questions**.**
Overview of methodology and Searching.

**UNIT II**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
Curriculum, Teacher education.

**UNIT III**

Evidence on the effectiveness of pedagogical practices
Methodology for the in depth stage: quality assessment of included studies.
How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
Theory of change.
Strength and nature of the body of evidence for effective pedagogical practices.
Pedagogic theory and pedagogical approaches.
Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT IV**

Professional development: alignment with classroom practices and follow- up support

Peer support

Support from the head teacher and the community.

Curriculum and assessment

Barriers to learning: limited resources and large class sizes

**UNIT V**

**Research gaps and future directions**

Research design
Contexts
Pedagogy
Teacher education
Curriculum and assessment
Dissemination and research impact.

**Text Books:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

**Reference Books:**

1. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
2. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.

**Web Links:**

1. www.pratham.org/images/resource%20working%20paper%202.pdf.

| Course Title | STRESS MANAGEMENT BY YOGA (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1870A07 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- To achieve overall health of body and mind.
- To overcome stress

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| CO 1 | Develop healthy mind in a healthy body thus improving social health also |
| CO 2 | Improve efficiency. |

**UNIT I**

Definitions of Eight parts of yog. ( Ashtanga )

**UNIT II**

- Yam and Niyam. Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**UNIT III**

- Asan and Pranayam
  i)Various yog poses and their benefits for mind & body
  ii)Regularization of breathing techniques and its effects- Types of pranayam

**Text Books:**

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature" .
3. Advaitashrama (Publication Department), Kolkata.
4. Acharya Yatendra, Yoga & Stress Management, Finger Print Publishing.

| Course Title | PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Audit Course) | | | | M.Tech RE I / II Sem | | |
|---|---|---|---|---|---|---|---|
| Course Code | Category | Hours/Week | | | Credits | Maximum Marks | |
| 1870A08 | Audit Course | L | T | P | C | Continuous Internal Assessment | End Exams | Total |
| | | 2 | 0 | 0 | 0 | 40 | -- | 40 |
| Mid Exam Duration: 2 Hours | | | | | | | | |

**Course Objectives:**

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students.

**Course Outcomes: On successful completion of this course, the students will be able to**

| | |
|---|---|
| **CO 1** | Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life |
| **CO 2** | The person who has studied Geeta will lead the nation and mankind to peace and prosperity |
| **CO 3** | Study of Neetishatakam will help in developing versatile personality of students |

**UNIT I**

Neetisatakam-Holistic development of personality

- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

**UNIT II**

- Approach to day to day work and duties.
- Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

**UNIT III**

- Statements of basic knowledge.
- Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

**Text Books:**

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,Rashtriya Sanskrit Sansthanam, New Delhi.
3. Enlightenment: Personality Development and management, Sagir Ahmed, Independently Published.