K.S.R.M.
COLLEGE OF ENGINEERING

(UGC - Autonomous)
Accredited by NAAC with A+ Grade & B.Tech. (EEE, ECE, CSE, CE and ME) Programs by NBA
An ISO 9001:2015, 14001: 2015 & 50001: 2018 Certified Institution

ACADEMIC REGULATIONS (R25PG)
COURSE STRUCTURE AND SYLLABI

(Effective for the students admitted into I year
from the academic year 2025 -2026 onwards)

MASTER OF TECHNOLOGY (M.TECH.)
RENEWABLE ENERGY
(REGULAR, FULL-TIME)

K.S.R.M. COLLEGE OF ENGINEERING

VISION:

To evolve as a centre of repute for providing quality academic programs amalgamated with creative learning and research excellence to produce graduates with leadership qualities, ethical and human values to serve the nation.

MISSION:

M1. Provide high quality education with enriched curriculum blended with impactful Teaching-Learning practices.

M2. Promote Research, Entrepreneurship and Innovation through industry collaborations.

M3. Produce highly competent professional leaders for contributing to socio-economic development of the region and the nation.

DEPARTMENT
OF
MECHANICAL ENGINEERING

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.

M.Tech. RENEWABLE ENERGY

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1. To equip postgraduates with advanced knowledge and analytical skills in renewable energy technologies for designing and optimizing sustainable energy systems.

PEO2. To enable graduates to contribute effectively in research organizations, academia, industries, and energy sectors by applying appropriate tools and technologies in renewable energy generation and management.

PEO3. To foster innovation, entrepreneurship, and lifelong learning in emerging areas such as solar, wind, bioenergy, hydrogen, and hybrid energy systems.

PEO4. To inculcate professional ethics, communication skills, and leadership qualities for effective participation in multidisciplinary teams and for contributing toward sustainable and clean energy development.

PROGRAM OUTCOMES (POs)

After successful completion of the program, graduates will be able to:

PO1. Apply advanced concepts of renewable energy engineering to analyze, design, and implement sustainable energy systems.

PO2. Conduct research and investigations to address challenges in energy conversion, storage, and integration of renewable energy sources with conventional grids.

PO3. Design and develop efficient, reliable, and environment-friendly renewable energy systems and technologies that meet technical and regulatory standards.

PO4. Utilize advanced simulation, modelling, and optimization tools for performance analysis, techno-economic evaluation, and management of renewable energy projects.

PO5. Communicate effectively with the engineering community and society at large, demonstrating professional ethics and accountability in renewable energy practices.

PO6. Engage in lifelong learning to adapt to evolving technologies and understand the societal, environmental, and global impacts of renewable energy solutions.

K.S.R.M. COLLEGE OF ENGINEERING

(AUTONOMOUS)

Academic Regulations of M.Tech. (Full Time/Regular) Programme

(Effective for the students admitted into I year from the Academic Year 2025-26 and onwards)

K.S.R.M. College of Engineering (KSRMCE) offers **Two** Years (**Four** Semesters) full-time Master of Technology (M.Tech.) Degree programme, under Choice Based Credit System (CBCS) in different branches of Engineering and Technology with different specializations.

The affiliating university Jawaharlal Nehru Technological University Anantapur shall confer M.Tech. degree on candidates who are admitted to the programme and fulfill all the requirements for the award of the degree.

1. Award of the M.Tech. Degree

A student will be declared eligible for the award of the M.Tech. degree if he/she fulfils the following:

1.1 Pursues a course of study for not less than two academic years and not more than four academic years.

1.2 Registers for 75 credits and secures all 75 credits.

2. Students, who fail to fulfil all the academic requirements for the award of the degree within four academic years from the year of their admission, shall forfeit their seat in M.Tech. course and their admission stands cancelled.

3. Programme of Study:

The following M.Tech. Specializations are offered at present in different branches of Engineering and Technology and are as follows:

Discipline	**Name of the Specialization**	**Code**
Civil Engineering	Geo Technical Engineering	12
Electrical and Electronics Engineering	Power Systems	52
Mechanical Engineering	Renewable Energy	99
Computer Science and Engineering	Artificial Intelligence and Data Science	98
Electronics & Communication Engineering	Embedded Systems & VLSI	84

4. Eligibility for Admissions:

4.1 Admission to the M. Tech Program shall be made subject to the eligibility, qualification and specialization prescribed by the A.P. State Government/University from time to time.

4.2 Admissions shall be made either on the basis of either the merit rank or Percentile obtained by the qualified student in the relevant qualifying GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by A.P. State Government (APPGECET) for M.Tech. programmes an entrance test conducted by University/on the basis of any other exams approved by the University, subject to reservations as laid down by the Govt. from time to time.

5. Programme related terms:

5.1 ***Credit:*** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (Lecture/Tutorial) or two hours of practical work/field work per week.

Credit definition:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit

5.2 ***Academic Year:*** Two consecutive (one odd + one even) semesters constitute one academic year.

5.3 ***Choice Based Credit System (CBCS):*** The CBCS provides choice for students to select from the prescribed courses.

6. Programme Pattern:

6.1 Total duration of the of M.Tech. programme is two academic years

6.2 Each academic year of study is divided into two semesters.

6.3 Each Semester shall be of 22 weeks duration (inclusive of Examinations), with a minimum of 90 instructional days per semester.

6.4 The student shall not take more than four academic years to fulfill all the academic requirements for the award of M.Tech. degree from the date of commencement of first year first semester, failing which the student shall forfeit the seat in M.Tech. programme.

6.5 The medium of instruction of the programme (including examinations and project reports) will be in English only.

6.6 All subjects/courses offered for the M.Tech. degree programme are broadly classified as follows:

S. No.	Broad Course Classification	Course Category	Description
1.	Core Courses	Foundational & Professional Core Courses (PC)	Includes subjects related to the parent discipline / department / branch of Engineering/specialization.
2.	Elective Courses	Professional Elective Courses (PE)	Includes elective courses related to the parent discipline / department / branch of Engineering
		Open Elective Courses (OE)	Elective courses which include inter-disciplinary courses or courses in an area outside the parent discipline which are of importance in the context of special skill development
3.	Mandatory Courses	Quantum Technology and Application	To understand importance of latest technologies, research and process of creation of patents through research
		Research methodology & IPR	
4.		Skill Enhancement courses (SE)	Interdisciplinary / job-oriented / domain courses which are relevant to the industry
		Comprehensive Viva	To test the overall domain knowledge

S. No.	Broad Course Classification	Course Category	Description
		Short Term Industry Internship	To provide real time exposure
		Dissertation	To provide application of domain knowledge to solve real problems
5.	Audit Courses	Mandatory non-credit courses	Covering courses of developing desired attitude among the learners.

6.7 The college shall take measures to implement Virtual Labs (https://www.vlab.co.in) which provide remote access to labs in various disciplines of Engineering and will help student in learning basic and advanced concept through remote experimentation. Student shall be made to work on virtual lab experiments during the regular labs.

6.8 A faculty advisor/mentor shall be assigned to each specialization to advise students on the programme, its Course Structure and Curriculum, Choice of Courses, based on his competence, progress, pre-requisites and interest.

6.9 Preferably 25% course work for the theory courses in every semester shall be conducted in the blended mode of learning.

7. Attendance Requirements:

7.1 A student shall be eligible to appear for the Semester-End examinations if he/she acquires i) a minimum of 50% attendance in each course and ii) 75% of attendance in aggregate of all the courses.

7.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

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

7.4 Students whose shortage of attendance is not condoned in any semester are not eligible to take their semester-end examination of that class.

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

7.6 A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester. They may seek re-admission into that semester when offered next.

7.7 If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

7.8 If the learning is carried out in blended mode (both offline & online), then the total attendance of the student shall be calculated considering the offline and online attendance of the student.

8. Evaluation – Distribution and Weightage of Marks:

The performance of a student in each semester shall be evaluated course - wise (irrespective of credits assigned), for a maximum of 100 marks for theory and 100 marks for practical, based on Internal Evaluation and Semester-End Examination.

8.1 There shall be five units in each of the theory courses. For the theory courses 60 marks will be for the Semester-End Examination and 40 marks will be for Internal Evaluation.

8.2 Two Internal Examinations shall be conducted for 30 marks each, one in the middle of the Semester and the other immediately after the completion of instruction period. The

other 10 marks is awarded for continuous assessment in the form of assignments, quizzes, open book examination, presentation, etc. First mid examination shall be conducted for I & II units of the syllabus and second mid examination for III, IV & V units. Each mid exam shall be conducted for a total duration of 120 minutes with 3 questions (without choice) and each question carries 10 marks. Final Internal marks for a total of 40 marks shall be arrived at by considering the marks secured by the student in both the internal examinations with 80% weightage to the better internal exam and 20% to the other.

8.3 The following pattern shall be followed in the End Examination:

i. Five questions shall be set from each of the five units with either/or type for 12 marks each.
ii. All the questions have to be answered compulsorily.
iii. Each question may consist of one, two or more sub-questions.

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

The internal evaluation based on the day-to-day work-10 marks, record- 10 marks and the remaining 20 marks to be awarded by conducting an internal laboratory test. The semester-end examination shall be conducted by the examiners, with a breakup mark of Procedure-10, Experimentation-25, Results-10, Viva-Voce-15.

8.5 There shall be Mandatory **Audit courses** in I & II semesters for zero credits. There is no external examination for audit courses. However, attendance shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course only when he/she secures 50% or more in the internal examinations. In case, the student fails, a re-examination shall be conducted for failed candidates for 40 marks for every six months/semester satisfying the conditions mentioned in item 1 & 2 of the regulations.

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

8.7 In case the candidate does not secure the minimum academic requirement in any of the courses he/she has to reappear for the Semester-End Examination either supplementary or regular in that course or repeat the course when next offered or do any other specified course as may be required.

8.8 The laboratory records and mid semester test papers shall be preserved for a minimum of 3 years in the respective institutions as per the University norms and shall be produced to the Committees of the University as and when the same are asked for.

9. Credit Transfer Policy

As per University Grants Commission (Credit Framework for Online Learning Courses through SWAYAM) Regulation, 2016, students are allowed to do up to a maximum of 40% of the Professional and Open Electives in a semester through SWAYAM/SWAYAM Plus.

9.1 The college offers credit mobility for MOOCs and give the equivalent credit weightage to the students for the credits earned through online learning courses through SWAYAM platform.

9.2 The online learning courses available on the SWAYAM platform will be considered for

credit transfer. SWAYAM course credits are as specified in the platform

9.3 Student registration for the MOOCs shall be only through the college, it is mandatory for the student to share necessary information with the college

9.4 The institution will list out the courses to be permitted for credit transfer through SWAYAM. However, while selecting courses in the online platform institution would essentially avoid the courses offered through the curriculum in the offline mode.

9.5 The institution will notify at the beginning of semester the list of the online learning courses eligible for credit transfer in the forthcoming Semester.

9.6 Students may register for an 8-week (2 credits) or 12-week (3 credits) SWAYAM / SWAYAM plus course with the approval of the Head of the Department (HoD).

9.7 Examination fees, if applicable, shall be borne by the student. Pass marks and grading will be as per the JNTUA academic regulations.

9.8 A student must get minimum 40% marks for assignments and quizzes on the SWAYAM/ SWAYAM plus platform to be eligible for the semester-end examination. The students who are unable to get minimum internal marks in SWAYAM/ SWAYAM plus platform, they have to re-register for the course in subsequent semester through SWAYAM/ SWAYAM plus platform.

9.9 The semester-end exam may be conducted by the National Testing Agency (NTA), the National Programme on Technology Enhanced Learning (NPTEL) or the College during the regular end-term exams. Evaluation shall comprise 60% weightage for the semester-end examination and 40% for assignments and quizzes conducted by the SWAYAM/ SWAYAM plus course coordinator. The student has to get 50% marks for internal and external with minimum of 40% marks in the external examination to declare them as pass.

9.10 The institution also ensures that the student completes the course and produces the course completion certificate as per the academic schedule given for the regular courses in that semester. However, the credits will be transferred to the students who got minimum 50% marks with 40% marks in the external examination

9.11 The institution will designate a faculty member as a Mentor for each course to guide the students from registration till completion of the credit course.

9.12 The college will ensure no overlap of SWAYAM MOOC exams with that of the semester-end examination schedule. In case of delay in SWAYAM results, the college will re-issue the marks sheet for such students.

9.13 Student pursuing courses under MOOCs shall acquire the required credits only after successful completion of the course and submitting a certificate issued by the competent authority along with the minimum 50% of marks and grades.

9.14 The institution maintains the following in the examination section and submits as and when demanded by the university:

a) List of students who have passed MOOC courses in the current semester along with the certificates of completion.
b) Undertaking form filled by the students for credit transfer.

9.15 The college will resolve any issues that may arise in the implementation of this policy from time to time and shall review its credit transfer policy in the light of periodic changes brought by UGC, SWAYAM, NPTEL and state government.

Note: Students are also be permitted to register for MOOCs offered through online platforms other than SWAYAM NPTEL. In such cases, credit transfer shall be permitted only after seeking approval of the Principal with the recommendations of the concerned HoD and Dean, Academics at least three months prior to the commencement of the semester.

10. Re-registration for Improvement of Internal Evaluation Marks:

A candidate shall be given one chance to re-register for each course provided the internal marks secured by a candidate are less than 50% and has failed in the end examination

10.1 The candidate should have completed the course work and obtained examinations results for **I, II and III** semesters.

10.2 The candidate should have passed all the courses for which the Internal Evaluation marks secured are more than 50%.

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

10.4 The candidate has to re-register for the chosen courses and fulfill the academic requirements.

10.5 For re-registration, the candidates have to apply to the Principal through the respective HoD by paying the requisite fees and get approval from the Principal before the start of the semester in which re-registration is required

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

11. Evaluation of Project/Dissertation Work:

The Project work shall be initiated at the beginning of the III-Semester and the duration of the Project is of two semesters. Evaluation of Project work is for 300 marks with 200 marks for internal evaluation and 100 marks for external evaluation. Progress of the project work is monitored through three reviews:

- Project review – I at the beginning of the III semester for zero marks
- Project review – II at the end of the third semester for 100 marks
- Project review – III before submission of the thesis i.e., end of the IV semesters for 100 marks

External evaluation of final Project work viva voce in IV semester shall be for 100 marks.

A Project Review Committee (PRC) shall be constituted with the Head of the Department as Chairperson, Project Supervisor and one faculty member of the department offering the M.Tech. programme.

11.1 A candidate is permitted to register for the Project Work in III Semester after satisfying the attendance requirements in all the courses, both theory and laboratory (in I & II semesters).

11.2 A candidate is permitted to submit Project dissertation with the approval of PRC. The candidate has to pass all the theory, practical and other courses before submission of the Thesis.

11.3 Project work shall be carried out under the supervision of teacher in the parent department concerned.

11.4 A candidate shall be permitted to work on the project in an industry/research organization on the recommendation of the Head of the Department. In such cases, one of the teachers from the department concerned would be the internal guide and an expert

from the industry/research organization concerned shall act as co-supervisor/external guide. It is mandatory for the candidate to make full disclosure of all data/results on which they wish to base their dissertation. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. A certificate from the external supervisor is to be included in the dissertation.

11.5 Continuous assessment of Project Work - I and Project Work – II in III & IV semesters respectively will be monitored by the PRC.

11.6 The candidate shall submit status report by giving seminars in three different phases (two in III semester and one in IV semester) during the project work period. These seminar reports must be approved by the PRC before submission of the Project Thesis.

11.7 After registration, a candidate must present in Project Review - I, in consultation with his Project Supervisor, the title, objective and plan of action of his Project work to the PRC for approval within four weeks from the commencement of III Semester. Student shall initiate the project work, only after obtaining the approval of the PRC.

11.8 The Project Review - II in III semester carries internal marks of 100. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and PRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Project Work.

11.9 A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - II. Only after successful completion of Project Review – II, candidate shall be permitted for Project Work Review – III in IV Semester. The unsuccessful students in Project Review - II shall reappear after three months.

11.10 The Project Review - III in IV semester carries 100 internal marks. Evaluation should be done by the PRC for 50 marks and the Supervisor will evaluate it for the other 50 marks. The PRC will examine the overall progress of the Project Work and decide whether or not eligible for final submission. A candidate has to secure a minimum of 50% of marks to be declared successful in Project Review - III. If student fails to obtain the required minimum marks, he/she has to reappear for Project Review - III after a month.

11.11 For the approval of PRC, the candidate shall submit the draft copy of dissertation to the Head of the Department and make an oral presentation before the PRC.

11.12 After approval from the PRC, the student is permitted to submit a report. The dissertation report will be accepted only when the plagiarism is within 30% checked through Turnitin software (repository mode). The plagiarism report shall be submitted along with the dissertation report.

11.13 Research paper related to the Project Work shall be published in an SCI/ESCI/Scopus/UGC Care listed journal, or in conference proceedings with ISBN number organized by professional societies such as IEEE, IEI, etc.

11.14 After successful plagiarism check and publication of research paper, three copies of the dissertation certified by the supervisor and HOD shall be submitted to the College.

11.15 The dissertation shall be adjudicated by an external examiner selected by the College. For this, a panel of three examiners shall be submitted by the supervisor concerned and department head for each student. However, the dissertation will be adjudicated by one examiner nominated by the Principal.

11.16 If the report of the examiner is not satisfactory, the candidate shall revise and resubmit

the dissertation, in the time frame as decided by the PRC. If report of the examiner is unfavorable again, the thesis shall be summarily rejected. The candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the Principal.

11.17 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Project Viva voce exam.

11.18 The Project Viva voce examinations shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who has adjudicated the dissertation. For Dissertation Evaluation (Viva voce) in IV Sem. there are external marks of 100 and it is evaluated by external examiner. The candidate has to secure a minimum of 50% marks in Viva voce exam.

11.19 If he fails to fulfill the requirements as specified, he will reappear for the Project Viva voce examination only after three months. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for the award of the degree.

12 Industry Internships:

Industry internship either onsite or virtual with a minimum of 06-08 weeks duration, done at the end of 1st year second semester. It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Power projects, software MNCs or any industries in the areas of concerned specialization of the PG program. The student shall register for the internship as per course structure after commencement of academic year.

Evaluation of the summer internships shall be through the departmental committee. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the departmental committee comprising of Head of the Department, Mentor/Supervisor of the internship and a senior faculty member of the department. A certificate of successful completion from industry shall be included in the report. Internship will be evaluated for 100 marks with 50 marks for the report evaluated by the mentor and 50 marks for oral presentation. A student should secure minimum 50% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the College.

13 Comprehensive Viva

A Comprehensive Viva shall be conducted after the II Semester examinations for 100 marks by a committee consisting of the Head of the Department, one senior faculty member of the same specialization, and an external subject expert appointed by the Principal. The student must secure a minimum of 50% marks to be declared as passed

14 Credits for Co-curricular Activities

A Student should earn 01 credits under the head of co-curricular activities, viz., attending Conference, Scientific Presentations and Other Scholarly Activities.

Following are the guidelines for awarding Credits for Co-curricular Activities

Name of the Activity	Maximum Credits / Activity
Participation in National Level Seminar / Conference / Workshop / Training programs (related to the specialization of the student)	0.5
Participation in International Level Seminar / Conference / Workshop / Training programs held outside India (related to the specialization of the student)	1
Academic Award/Research Award from State Level / National Agencies	0.5
Academic Award / Research Award from International Agencies	1
Research / Review Publication in National Journals (Indexed in Scopus / Web of Science)	0.5
Research / Review Publication in International Journals with Editorial board outside India (Indexed in Scopus / Web of Science)	1

Note:

i) Credit shall be awarded only for the first author. Certificate of attendance and participation in a Conference/Seminar is to be submitted for awarding credit. A minimum participation of five days is required to earn the necessary credits. Alternatively, the student may attend five different one day programs to meet this requirement.

ii) Certificate of attendance and participation in workshops and training programs (Internal or External) is to be submitted for awarding credit. The total duration should be at least one week.

iii) Participation in any activity shall be permitted only once for acquiring required credits under cocurricular activities

15 Grading:

As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades and corresponding percentage of marks shall be followed:

After each course is evaluated for 100 marks, the marks obtained in each course will be converted to a corresponding letter grade as given below, depending on the range in which the marks obtained by the student fall.

Structure of Grading of Academic Performance

Range in which the marks in the course fall	Grade	Grade points Assigned
≥ 90	S (Superior)	10
≥ 80 < 90	A (Excellent)	9
≥ 70 < 80	B (Very Good)	8
≥ 60 < 70	C (Good)	7
≥ 50 < 60	D (Pass)	6
< 50	F (Fail)	0
Absent	Ab (Absent)	0

i) A student obtaining Grade "F" or Grade "Ab" in a course shall be considered failed and will be required to reappear for that course when it is offered the next supplementary examination.

ii) For noncredit audit courses, "Satisfactory" or "Unsatisfactory" shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA / CGPA / Percentage.

Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The Semester Grade Point Average (SGPA) is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$SGPA = \Sigma (C_i \times G_i)/\Sigma C_i$

where, C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course.

i) The Cumulative Grade Point Average (CGPA) will be computed in the same manner considering all the courses undergone by a student over all the semesters of a program, i.e.,

   $CGPA = \Sigma (C_j \times S_i)/ \Sigma C_j$

   where "S_i" is the SGPA of the i^{th} semester and C_j is the total number of credits up to that semester.

ii) Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

iii) While computing the SGPA the courses in which the student is awarded Zero grade points will also be included.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters S, A, B, C, D and F.

16 Award of Class:

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

Class Awarded	CGPA to be secured
First Class with Distinction	≥7.5%
First Class	< 7,5≥ 6.5
Pass Class	< 6.5

17 **Exit Policy:**

The student shall be permitted to exit with a PG Diploma based on his/her request to the university through the respective institution at the end of first year subject to passing all the courses in first year.

The Academic Council shall resolve any issues that may arise in the implementation of this policy from time to time and shall review the policy in the light of periodic changes brought by UGC, AICTE and State government.

18 Withholding of Results:

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

19 **Transitory Regulations**

Discontinued, detained, or failed candidates are eligible for readmission as and when the semester is offered after fulfilment of academic regulations. Candidates who have been detained for want of attendance or not fulfilled academic requirements or who have failed after having undergone the course in earlier regulations or have discontinued and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent courses as and when courses are offered, subject to Section 2 and they will follow the academic regulations into which they are readmitted.

20 General:

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

20.2 Disciplinary action for Malpractice / improper conduct in examinations is appended.

20.3 There shall be no places transfer within the constituent colleges and affiliated colleges of Jawaharlal Nehru Technological University Anantapur.

20.4 Where the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

20.5 In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.

20.6 The College may change or amend the academic regulations or syllabi at any time and the changes or amendments shall be made applicable to all the students on rolls with effect from the dates notified by the College.

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RULES FOR

DISCIPLINARY ACTION FOR MALPRACTICES / IMPROPER CONDUCT IN EXAMINATIONS

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
1.(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the course of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the course of the examination).	Expulsion from the examination hall and cancellation of the performance in that course only.
1.(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that course only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred for four consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the courses of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses of that semester/year. The candidate is also debarred for four consecutive semesters from class work and all University examinations if his

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
		involvement is established. Otherwise, the candidate is debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that course only.
6.	Refuses to obey the orders of the Chief Superintendent /Assistant - Superintendent /any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses of that semester / year. If the candidate physically assaults the invigilator / officer-in-charge of the Examinations, then the candidate is also debarred and forfeits his/her seat. In case of outsiders, they will be handed over to the police and a police case is registered against them.

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
	of the examination.	
7	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	Possessany lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester / year. The candidate is also debarred and forfeits the seat. Person (s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester / year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that course only or in that course and all other courses the candidate has appeared including practical examinations and project work of that semester / year

S.No.	Nature of Malpractices / Improper conduct	Punishment
	If the candidate:	
		examinations, depending on the recommendation of the committee.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

1. Malpractices identified by squad or special invigilators
2. Punishments to the candidates as per the above guidelines.
3. Punishment for institutions: (if the squad reports that the college is also involved in encouraging malpractices)
4. A show cause notice shall be issued to the college.
5. Impose a suitable fine on the college.
6. Shifting the examination center from the college to another college for a specific period of not less than one year.

Note:

Whenever the performance of a student is cancelled in any course/courses due to Malpractice, he has to register for End Examinations in that course/courses consequently and has to fulfil all the norms required for the award of Degree.

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COURSE STRUCTURE
M.Tech. RENEWABLE ENERGY
I-SEMESTER

S. No.	Course Code	Course Title	Category	Hours per week			Credits
				L	T	P	
1.	2599101	Energy Audit and Management	PC	3	0	0	3
2.	2599102	Introduction to Renewable Energy Systems	PC	3	0	0	3
3.	**Program Elective-I**		PE	3	0	0	3
	2599103	Hydrogen and Fuel Cell Technologies					
	2599104	Solar Energy Technology					
	2599105	Process Modeling and Simulation in Renewable Energy Systems					
4.	**Program Elective-II**		PE	3	0	0	3
	2599106	Energy Storage Technology					
	2599107	Energy Conservation by Waste heat recovery					
	2599108	Developing Energy Efficiency and Renewable energy Projects					
5.	2599151	Fuels Lab	PC	0	0	4	2
6.	2599152	Solar Energy Engineering Lab	PC	0	0	4	2
7.	2599153	Bioenergy Lab	SE	0	1	2	2
8.	2599171	Research Methodology and Intellectual Property Rights	MC	2	0	0	2
9.	**Audit Course–I**		AC	2	0	0	2
	2599181	English for Research Paper Writing					
	2512181	Disaster Management					
	2598181	Essence of Indian Traditional Knowledge					
			TOTAL	**16**	**1**	**10**	**22**

2599101	M.Tech., I-SEMESTER ENERGY AUDIT AND MANAGEMENT (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Identify and describe various energy resources, their utilization patterns, and their impact on the environment.

CO2. Apply the concepts of energy and heat balance to identify and analyze energy conservation opportunities in industrial and building systems.

CO3. Conduct energy audits using appropriate instruments and evaluate energy performance for effective energy management.

CO4. Formulate energy policies and develop action plans with suitable financial analysis and implementation strategies.

CO5. Apply project management principles and monitoring techniques for efficient and sustainable energy utilization.

SYLLABUS:

UNIT- I: ENERGY SCENARIO (10 Periods)

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 (10 Periods)

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, Energy Monitoring, 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 (08 Periods)

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 (09 Periods)

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 of ESCOs.

UNIT- V: PROJECT MANAGEMENT **(08 Periods)**

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).

Total Periods: 45

Textbooks:

T1. Guide to Energy Management, Capehart, B. L., Turner, W. C., & Kennedy, W. J. The Fairmont Press, Inc. Atlanta, 2019

T2. Handbook of Energy Engineering, Thumann, A., & Mehta, D. P., CRC Press, 2001

T3. Energy Conservation in the Process Industries, Kenney W. F., Academic Press, 2012.

Reference Books:

R1. Energy Management Handbook (Vol. 2). Turner, W. C., & Doty, S. Lulu Press, 2013

R2. Energy Management and Conservation Hand Book. Kreith, F. & Goswami, D. Y. CRC Press, 2007.

R3. Environment Management and Audit. Rao, P. S., & Rao, P. R. Deep Publications, 2000

Web Resources:

1. https://nptel.ac.in/courses/108106022?utm_source=chatgpt.com
2. https://onlinecourses.swayam2.ac.in/nou23_es05/preview?utm_source=chatgpt.com
3. https://onlinecourses.nptel.ac.in/noc23_hs69/preview?utm_source=chatgpt.com

2599102	M.Tech., I-SEMESTER INTRODUCTION TO RENEWABLE ENERGY SYSTEMS (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. explain the need and fundamentals of various renewable energy sources and solar radiation concepts.

CO2. analyse solar thermal, photovoltaic, and wind energy systems and their performance.

CO3. evaluate biomass conversion and geothermal energy technologies for sustainable power generation.

CO4. describe and compare hydro and ocean energy systems and their applications.

CO5. apply the principles of fuel cells and hydrogen energy systems for clean energy solutions.

SYLLABUS:

UNIT-I: NEED OF SOURCES OF RENEWABLE ENERGY: (09 Periods)

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 measuring instrument, applications etc.

UNIT-II: SOLAR AND WIND ENERGY (09 Periods)

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: BIO AND GEOTHERMAL ENERGY (09 Periods)

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 AND OCEAN ENERY (09 Periods)

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 (09 Periods)

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.

Total Periods: 45

Textbooks:

T1. Solar Engineering of Thermal Processes, Duffie, J. A., & Beckman, W. Wiley Eastern Publications. 2013, Fourth Edition.
T2. Fundamentals of Renewable Energy Sources, Tiwari, G. N., & Ghosal, M. K., Alpha Science International Limited, 2007.
T3. Fundamentals of Renewable Energy Systems, Mukherjee, D., & Chakrabarti, S. New Age International, 2014.

Reference Books:

R1. Solar Energy Principles of Thermal Collection and Storage, Sukhatme, S. P. Tata McGraw Hill Publishing Company Ltd. New Delhi, 2009.
R2. Renewable Energy Sources and Emerging Technologies by D.P. Kothari, K. C. Singal, Rakesh Ranjan, PHI Learning Pvt. Limited New Delhi, 2011.

Web Resources:

1. https://mnre.gov.in
2. https://niwe.res.in
3. https://www.irena.org

2599103	M.Tech., I-SEMESTER HYDROGEN AND FUEL CELL TECHNOLOGIES (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the properties and various production methods of hydrogen.
CO2. Describe hydrogen storage techniques, safety aspects, and applications.
CO3. Analyse the principles, thermodynamics, and performance of fuel cells.
CO4. Compare different types of fuel cells and their characteristics.
CO5. Evaluate the applications, economics, and environmental benefits of hydrogen and fuel cells.

SYLLABUS:

UNIT-I: HYDROGEN – BASICS AND PRODUCTION TECHNIQUES (09 Periods)

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

UNIT-II: HYDROGEN STORAGE AND APPLICATIONS (09 Periods)

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage comparisons. Safety and management of hydrogen, Applications of Hydrogen.

UNIT-III: FUEL CELLS (09 Periods)

History – principle - working - thermodynamics and kinetics of fuel cell process performance evaluation of fuel cell – comparison on battery vs fuel cell.

UNIT-IV: TYPES OF FUEL CELLS (09 Periods)

Introduction to Fuel Cell Classification, Alkaline Fuel Cell (AFC), Phosphoric Acid Fuel Cell (PAFC), Proton Exchange Membrane Fuel Cell (PEMFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cell (SOFC), Comparative Analysis and Recent Developments – Relative merits and demerits.

UNIT-V: APPLICATION OF FUEL CELL AND ECONOMICS (09 Periods)

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

Total Periods: 45

Textbooks:

T1. Fuel Cells, Engines and Hydrogen, Barclay F.J., Wiley, 2009.
T2. Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorensen Elsevier, UK 2005.
T3. Fuel Cells: Theory and Application, Hart A.B. and G.J. Womack, Prentice H all, New York Ltd., 1989.

Reference Books:

R1. The Hydrogen Economy, Jeremy Rifkin, Penguin Group, USA, 2002.
R2. Fuel Cell and Their Applications, Wiley-Vch, Kordesch K. and G. Simader, Germany, 1996.
R3. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn, Well Corporation, Oklahoma, 2005.
R4. Fuel Cells – Principles and Applications, Viswanathan B. and Aulice Scibioh.M.

Web Resources:

1. https://www.energy.gov/eere/fuelcells
2. https://www.iea.org/topics/hydrogen
3. https://www.fchea.org

2599104	M.Tech., I-SEMESTER SOLAR ENERGY TECHNOLOGIES (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the principles of solar radiation, its measurement, and analyze the performance characteristics of various solar collectors.

CO2. Describe and evaluate different solar thermal technologies and their applications in heating, cooling, desalination, and energy storage systems.

CO3. Illustrate the fundamental semiconductor physics and assess the efficiency parameters influencing solar photovoltaic cell performance.

CO4. Design and analyse solar PV systems for standalone, hybrid, and grid-connected applications considering system reliability, performance, and economic factors.

CO5. Apply the principles of solar passive architecture to develop energy-efficient building designs ensuring thermal comfort through natural heating and cooling.

SYLLABUS:

UNIT-I: SOLAR RADIATION AND COLLECTORS (09 Periods)

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 (09 Periods)

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 (09 Periods)

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 (09 Periods)

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 (09 Periods)

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.

Total Periods: 45

Textbooks:

T1. Principles of Solar Engineering, Goswami D.Y., Kreider, J. F. and Francis., Taylor and Francis, 2000.
T2. Solar Photovoltaics – Fundamental Technologies and Applications, Chetan Singh Solanki, PHI Learning Private Limited, 2011.

Reference Books:

R1. Solar Energy – Principle of Thermal Storage and collection, Sukhatme S.P. Nayak.J.P, Tata McGraw Hill, 2008.
R2. Solar Energy International, "Photovoltaic – Design and Installation Manual" New Society Publishers, 2006.
R3. Photovoltaic Systems Engineering, Roger Messenger and Jerry Vnetre, CRC Press, 2010.

Web Resources:

1. https://www.nrel.gov
2. https://www.solarenergy.org
3. https://mnre.gov.in

2599105	M.Tech., I-SEMESTER PROCESS MODELLING AND SIMULATION IN RENEWABLE ENERGY SYSTEMS (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the principles, types, and computational techniques used in modelling and simulation of energy systems.

CO2. Develop mathematical models for mechanical, electrical, thermal, fluid flow, and chemical systems using first-principle and empirical approaches.

CO3. Apply numerical and computational methods such as Euler's, Runge-Kutta, and Finite Element Techniques for solving lumped and distributed parameter models.

CO4. Analyze and optimize energy system performance using linear and nonlinear optimization methods with appropriate constraints.

CO5. Design and simulate energy systems using econometric and sensitivity analysis tools to assess uncertainty and improve decision-making.

SYLLABUS:

UNIT-I: INTRODUCTION TO MODELLING (09 Periods)

Types and classification, uses, limitations, advantages of modelling; Review of computational tools/techniques used for mathematical modelling including solutions for non-linear equations, system of simultaneous equations, conservation principles, thermodynamic principles.

UNIT-II: INTRODUCTION TO DEVELOPMENT BASED ON FIRST PRINCIPLES (09 Periods)

Steady state and dynamic, Lumped and distributed parameter models, Block diagrams and computer simulation. Modeling of Process elements consisting of Mechanical (translational and rotational), Electrical, Electro- mechanical, Fluid flow, Thermal and Chemical reaction system elements.

Development of Models: Grey box models, Empirical model building, Statistical model calibration and validation. Population balance models, examples of energy system modeling, static and dynamic modeling; Modeling errors, accuracy and methods of model validation.

UNIT-III: SOLUTION STRATEGIES FOR LUMPED PARAMETER MODELS (09 Periods)

Solution methods for initial value and boundary value problems, Euler's method, R-K method, Shooting method, Finite difference methods. Finite element and Finite volume methods. Solving the problems using MATLAB / SCILAB.

UNIT-IV: OPTIMIZATION (09 Periods)

Problem formulation with practical examples from energy system, constrained optimization and unconstrained problems: necessary and sufficiency conditions. Uses of Linear Programming technique for solution of problems related to Energy systems/ case studies. Constrained Optimization, Lagrange multipliers, constrained variations, Kuhn-Tucker conditions, Case studies of optimization in Energy systems problems, Dealing with uncertainty- probabilistic techniques.

UNIT-V: ENERGY SYSTEMS SIMULATION OPTIMIZATION (09 Periods)

Objectives / constraints, Problem formulation. Unconstrained problems, Necessary & Sufficiency conditions.

Econometric Modeling: Input Output models considering energy budgeting, Sensitivity analysis, importance of parametric analysis and tools for sensitivity analysis

Total Periods: 45

Textbooks:

T1. Engineering Optimization: Theory and Practice, Rao S. S. New Age International, 2004, Third Edition.
T2. A Guide to Econometrics, Kennedy P., Wiley-Blackwell, 2008, Sixth Edition.
T3. Energy Systems Analysis for Developing Countries, Meier P., Springer Verlag, 1984.

Reference Books:

R1. Engineering Optimization: Methods and Applications, Ravindran A. Ragsdell K. M. and Reklaitis G. V., Wiley, 2006, Second Edition.
R2. Applied Systems Analysis: Engineering Planning and Technology Management, Neufville R De. (1990). McGraw Hill.
R3. Hangos, K., & Cameron, I. (2001). Process modelling and model analysis. Academic Press.
R4. James, J. C. (1989). Process modeling, simulation and control for Chemical Engineers. McGraw Hill.
R5. Close, C. M., & Frederick, D. K. (2002). Modelling and analysis of dynamic systems John Wiley & Sons.

Web Resources:

1. https://www.nrel.gov
2. https://www.energyexemplar.com
3. https://www.mathworks.com

2599106	M.Tech., I-SEMESTER ENERGY STORAGE TECHNOLOGY (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the need for energy storage and compare various storage technologies based on their principles and applications.

CO2. Analyze the principles and performance of thermal and mechanical energy storage systems using energy and energy concepts.

CO3. Evaluate the characteristics and performance of different battery technologies and hydrogen-based energy storage systems.

CO4. Examine the working, modelling, and applications of various fuel cell types for power and transportation.

CO5. Apply energy storage technologies for practical uses such as food preservation, waste heat recovery, and solar energy systems.

UNIT-I: ENERGY AVAILABILITY (09 Periods)

Demand and storage, Need for energy storage, Different types of energy storage; Mechanical, Chemical, Electrical, Electrochemical, Biological, Magnetic, Electromagnetic, Thermal; Comparison of energy storage technologies.

UNIT-II: THERMAL AND MECHANICAL ENERGY STORAGE (09 Periods)

Thermal Storage: Principles and applications, Sensible and Latent heat, Phase change materials; Energy and exergy analysis of thermal energy storage, solar energy and thermal energy storage, case studies.

Mechanical Energy Storage: Flywheel and compressed air storage; Pumped hydro storage; Hydrogen energy storage, Capacitor and super capacitor, Electrochemical Double Layer Capacitor: Principles, performance and applications

UNIT-III: ELECTROCHEMICAL AND HYDROGEN ENERGY STORAGE (09 Periods)

Electrochemical Energy Storage: Battery – fundamentals and technologies, characteristics and performance comparison: Lead-acid, Nickel-Metal hydride, Lithium Ion; Battery system model, emerging trends in batteries.

Hydrogen Energy Storage: Hydrogen resources and production; Basic principle of direct energy conversion using fuel cells; Thermodynamics of fuel cells

UNIT-IV: FUEL CELLS (09 Periods)

AFC, PEMFC, MCFC, SOFC, Microbial Fuel cell, Fuel cell performance, characterization and modeling; Fuel cell system design and technology, applications for power and transportation.

UNIT-V: APPLICATIONS OF ENERGY STORAGE (09 Periods)

Food preservation, Waste heat recovery, Solar energy storage: Greenhouse heating; Drying and heating for process industries.

Total Periods: 45

Textbooks:

T1. Thermal Energy Storage: Systems and Applications, Dincer I., and Rosen M. A., Wiley Eastern, 2011.

T2. Energy Storage: Fundamentals, Materials and Applications, Huggins R. A., Springer, 2015.

T3. Fuel Cell Fundamentals, O'Hayre R., Cha S., Colella W., and Prinz F. B. Wiley Eastern, 2009, Second Edition.

Reference Books:

R1. Chemical and Electrochemical Energy System, Narayan R. and Viswanathan B., Universities Press 2011.
R2. Battery Systems Engineering, Rahn C. D. and Wang C., Wiley Eastern, 2013, First Edition.
R3. Electrochemical Energy Storage for Renewable Sources and Grid Balancing, Moseley P. T., and Garche J., Elsevier Science, 2014.

Web Resources:

1. https://www.energystorage.org/resources?utm_source
2. https://irecusa.org/our-work/energy-storage/?utm_source
3. https://www.nrel.gov/storage?utm_source

2599107	M.Tech., I-SEMESTER ENERGY CONSEVATION BY WASTE HEAT RECOVERY (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the sources of waste heat, its quality, and methods for optimal utilization of fossil fuels through combined and cogeneration systems.

CO2. Analyze energy principles and evaluate the performance of different industrial heat recovery systems and heat exchangers.

CO3. Describe the design and operation of waste heat boilers and heat pipe systems used for heat recovery applications.

CO4. Examine various waste heat utilization techniques in power generation, HVAC, and thermo electric systems.

CO5. Assess waste heat recovery and energy storage systems through quantitative, economic, and techno-feasibility analyses.

SYLLABUS:

UNIT-I: INTRODUCTION (09 Periods)

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

UNIT-II: EXERGY ANALYSIS (09 Periods)

Utilization of industrial waste heat; Properties of exhaust gas; Gas-to- gas, gas-to- liquid heat recovery systems; Recuperators and regenerators; Shell and tube heat exchangers; Spiral tube and plate heat exchangers.

UNIT-III: WASTE HEAT BOILERS (09 Periods)

Various types and design aspects. Heat pipes: theory and applications in waste heat recovery.

UNIT-IV: PRIME MOVERS (09 Periods)

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-V: WASTE HEAT RECOVERY CALCULATIONS AND NEED FOR ENERY STORAGE (09 Periods)

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

Need for Energy Storage: Thermal, electrical, magnetic and chemical storage systems.

Total Periods: 45

Textbooks:

T1. Process Heat Transfer, Hewitt, G. F., Shires, G. L., and Bott, T. R., CRC Press, Florida, 1993.
T2. Process Heat Transfer. Flynn, A. M., Akashige, T., & Theodore, L., John Wiley & Sons, 2018.
T3. Energy Conversion, Goswami, D. Y., and Kreith, F. CRC Press, 2007.

Reference Books:

R1. Process Heat Transfer: Principles, Applications and Rules of Thumb. Serth, R. W., & Lestina, T., Academic press, 2014.

R2. Small and Micro Combined Heat and power (CHP) systems: Advanced Design, Performance, Materials and Applications, Beith, R., Elsevier, 2018.
R3. Wealth from waste, Khanna S., & Mohan, K., Tata Energy Research Institute, 2019.

Web Resources:

1. https://www.energy.gov/sites/prod/files/2014/05/f15/35876.pdf
2. https://www.ipieca.org/resources/energy-efficiency-compendium
3. https://www.sigmathermal.com/how-do-waste-heat-recovery-systems-work

2599108	M.Tech., I-SEMESTER DEVELOPING ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECTS (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Explain the key drivers, motivation, and framework for developing energy efficiency and renewable energy projects within policy and regulatory environments.

CO2. Analyze pre-investment activities such as site selection, technology assessment, feasibility studies, and stakeholder engagement for successful project planning.

CO3. Evaluate project implementation processes including procurement, commissioning, risk management, and performance monitoring.

CO4. Examine the role of policies, sustainability considerations, and community participation in promoting renewable and energy efficiency projects.

CO5. Apply project development principles to real-world case studies on renewable energy, energy efficiency, and environmental management projects.

SYLLABUS:

UNIT-I: PROJECT MOTIVATION (09 Periods)

Key drivers-pre-development, gauging market characteristics that provide motivation for the project and assessment of market readiness, Project development framework, Essential elements, project development environment including existing policy environment- relevant codes (such as ECBC).

UNIT-II: PRE-INVESTMENT PHASE (09 Periods)

Assessing Potential Sites, identifying partners, Assessment of commercially available energy technologies for improving energy efficiency and harnessing renewable energy, preparation of business plan (that includes feasibility study, engineering design, Financial closure, permitting activities and related documentation and agreements), consensus with project stakeholders

UNIT-III: IMPLEMENTATION PHASE (09 Periods)

Procurement, land acquisition, site preparation, construction, installation, commissioning of the project, operation of the facility, Actual implementation of the business plan, Monitoring and evaluation of the business and the project performance, Issues in implementation of energy efficiency and renewable energy projects, Essential areas for strong project development in renewable energy - site, resource, permits, technology, team and capital, Size and diversity of potential project sponsors and also of projects in the field of renewable energy and energy efficiency.
Risks Factor: Risk in energy efficiency and renewable energy projects and appropriate de- risking/ mitigation measures and approaches, dispute resolution,

UNIT-IV: ROLE OF POLICIES, ISSUES AND CHALLENGES (09 Periods)

Role of Policies: Policy and support measures in promoting energy efficiency and renewable energy, developing community driven projects, developing projects for improving energy access, socially inclusive projects,
Issue And Challenges: Issues in using public lands for developing renewable energy projects, Various considerations in selecting local versus imported technologies, Challenges in implementing energy efficiency in public sector within government financial and other regulations, Environmental impact and sustainability assessment of energy efficiency and renewable energy projects and projects while addressing environmental issues, Utility scale versus local projects.

UNIT-V: EXAMPLES AND CASE STUDIES (09Periods)

Developing PV/wind power projects, projects for enhanced LED use in domestic, commercial,

institutional and industrial sectors, environmental management projects.

Total Periods: 45

Textbooks:

T1. Renewable Energy Project Development Under the Clean Development Mechanism: A Guide for Latin America, Lokey, E. Routledge, 2012.

T2. Framework for Project Development in the Renewable Energy Sector (No. NREL/TP-7A40-57963). National Renewable Energy Lab. (NREL), Springer, 2013.

T3. Guide to Developing a Community Renewable Energy Project in North America. Ontario Sustainable Energy Association, Montreal, Canada, 2010.

Reference Books:

R1. 16 Case Studies on the Deployment of Photovoltaic Technologies in Developing Countries. International Energy Agency IEA-PVPS.T9-07, 2003.

R2. Developing Renewable Energy Projects Larger Than 10 MWs at Federal Facilities, Report DOE/GO- 102013-3915, US Department of Energy Guide, 2003.

R3. Thomsen, K. (2014). Offshore wind: a comprehensive guide to successful offshore wind farm installation, Academic Press.

Web Resources:

1. https://unece.org/sites/default/files/2023
2. https://www.epa.gov/greenpower/renewable-energy-project-development-toolbox
3. https://www.epa.gov/greenpower/toolbox-renewable-energy-project-development

2599151	M.Tech., I-SEMESTER FUELS LAB (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Determine the physical and chemical properties of fuels and lubricants, including flash point, fire point, viscosity, and carbon residue.

CO2. Measure the calorific value of solid, liquid, and gaseous fuels using appropriate laboratory equipment.

CO3. Analyze fuel quality through standardized tests such as ASTM distillation, cloud point, and pour point for safe and efficient energy use.

CO4. Able to apply appropriate tools and techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

List of Experiments:

1. Determination of Flash Point and Fire Point of Liquid Fuels/Lubricants Using ables Apparatus.
2. Determination of Flash Point and Fire Point of Liquid Fuels/Lubricants Using Pesky Martens Test.
3. Carbon Residue Test
4. Determination of Viscosity of Liquid Lubricants and Fuels using Saybolt Viscometer.
5. Determination of Viscosity of Liquid Lubricants and Fuels using red wood viscometer-I & II.
6. Determination of Viscosity of Liquid Lubricants and Fuels using Engler viscometer.
7. Determination of calorific value of gaseous fuels using Junkers gas calorimeter.
8. Determination of calorific value of solid/liquid fuels using bomb calorimeter.
9. ASTM distillation test apparatus.
10. Cloud and Pour point apparatus.

Reference Books / Laboratory Manuals:

R1. ASTM Standards on Petroleum Products and Lubricants, ASTM International (for all testing procedures).

R2. Thermodynamics: An Engineering Approach, Cengel, Y.A. and Boles, M.A., McGraw Hill Education.

2599152	M.Tech., I-SEMESTER SOLAR ENERGY ENGINEERING LAB (RENEWABLE ENERGY)	L	T	P	C
		3	0	0	3

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Analyse the performance of solar PV modules under varying operating conditions.

CO2. Evaluate the efficiency and power flow of stand-alone PV systems with battery storage.

CO3. Examine the thermal performance of flat plate and parabolic trough solar collectors.

CO4. Able to apply appropriate tools and techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. Make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes

List of Experiments:

1. Determination of I-V& P-V Characteristics of a Solar PV Panel
2. Determination of I-V& P-V Characteristics of Series and Parallel combination of PV Modules
3. Determination of Characteristics of PV Module With a variation of the Tilt angle
4. Effect of Shading on Solar PV Module Output Power
5. Power Flow calculation of Stand-Alone PV System of DC Load with Battery
6. Charging and Discharging Characteristics of Battery
7. Determination of parameters of Flat Plate Collector – Forced Mode
8. Determination of parameters of Flat Plate Collector – Thermo siphon Mode
9. Determination of parameters of Flat Plate Collector for different mass flow rate
10. Determination of parameters of Flat Plate Collector for different radiation
11. Determination of parameters of Flat Plate Collector – Forced mode of flow at different wind speeds
12. Determination of parameters of Flat Plate Collector for Different Tilt Angle
13. Determination of parameters of Parabolic Trough Collector
14. Determination of parameters of Parabolic Trough Collector for different mass flow rate

Virtual Lab Experiments:

Link: **https://vlab.amrita.edu/index.php?sub=77&brch=298**

1. Solar Energy Measurements - Pyrheliometer
   (Direct Normal Irradiance (DNI) and Concentrating Solar Thermal Site Analysis)
2. Solar Energy Measurements - Pyrometer (Global Horizontal Irradiance (GHI))
   Solar Energy Measurements
3. To study the various solar irradiance measurements using pyrheliometer and pyranometers (Comparing the Global horizontal irradiance, diffuse horizontal irradiance and direct normal irradiance levels.)
4. Solar PV Tracker
   (Determining I-V and P-V curves and the Maximum Power Point for a Solar PV Cell under Varying Irradiance)
5. External Compound Parabolic Collector (XCPC) - Oil
   (Optimizing Flow Rate for Maximum Heat Absorption using Thermal Oil)
6. External Compound Parabolic Collector (XCPC) - Water

(Optimizing Flow Rate for Maximizing Heat Absorption using Water)

7. Parabolic Trough - Angle
   (Sensitivity to Solar Tracking Accuracy)
8. Parabolic Trough -Flow Rate
   (Optimizing Flow Rate for Maximum Heat Absorption using Water)

Reference Books/ Laboratory Manuals:

R1. Principles of Solar Engineering, Kreith, F. and Kreider, J.F., Hemisphere Publishing Corporation.

R2. Experiments in Solar Energy, K. Sukhatme Lab Manual, Tata McGraw Hill.

2599153	M.Tech., I-SEMESTER BIO ENERGY LAB (RENEWABLE ENERGY)	L	T	P	C
		0	1	2	2

COURSE OUTCOMES:

On successful completion of the course, the student will be able to

CO1. Analyze the physical and chemical characteristics of various biomass feedstocks for bioenergy applications.

CO2. Demonstrate and evaluate biofuel production processes such as biogas, bioethanol, and biodiesel generation.

CO3. Assess the performance and emission characteristics of biofuels and apply bioenergy conversion technologies for sustainable energy systems.

CO4. Able to apply appropriate Tools and Techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. Make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

List of Experiments:

1. Proximate Analysis of Biomass
2. Determination of Calorific Value of Biomass
3. Ultimate Analysis of Biomass
4. Design and Operation of a Laboratory-Scale Biogas Digester
5. Measurement of Methane Content in Biogas
6. Production of Bioethanol from Biomass
7. Determination of Ethanol Concentration
8. Measurement of methane content in biogas using a gas analyser.
9. Effect of parameters such as temperature, pH, and retention time on biogas yield.
10. Performance Evaluation of Biodiesel in a CI Engine (Demonstration)

Textbooks and Reference Books:

1. Bioenergy: Biomass to Biofuels and Waste to Energy, Anju Dahiya, Academic Press (Elsevier), 2020, Second Edition.
2. Biomass, Bioenergy and Bio economy: Sustainability and Resource Management, S. K. Sharma, R. K. Singh, Springer Nature, 2022, First Edition.
3. Biofuel Production, Performance and Emission Optimization, Manjunath Patel G. C., Ajith B. S., Jagadish, Arun Kumar Shettigar, Olusegun David Samuel, CRC Press, 2023, First Edition.

		L	T	P	C
2599171	**M.Tech., I-SEMESTER** **RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(MANDATORY COURSE)**	**2**	**0**	**0**	**2**

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Demonstrate the research process, types and methods, use data correctly, follow ethical rules, and use proper citation styles.

CO2. Apply appropriate data collection methods, identify data types and sources, ensure quality, and follow ethical practices using suitable tools.

CO3. Apply multivariate analysis and experimental design to study cause-effect relationships, ensure measurement validity, and write structured research papers and proposals.

CO4. Demonstrate the concept, evolution, and types of Intellectual Property Rights (IPR), recognize global IPR practices and institutions like WIPO, WTO, and UNESCO, and identify key agreements, trade secrets, and biodiversity-related rights.

CO5. Demonstrate the concept, features, and benefits of patents; identify types of patent applications and the filing process; and explain the roles of patent agents, licensing, and patent regulations.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF RESEARCH METHODOLOGY (09 Periods)

Overview of research process and design - Types of Research - Approaches to Research (Qualitative vs Quantitative) - Observation studies, Experiments and Surveys - Use of Secondary and exploratory data to answer the research question - Importance of Reasoning in Research and Research ethics - Documentation Styles (APA/IEEE etc.) - Plagiarism and its consequences.

UNIT-II: DATA COLLECTION AND SOURCES (09 Periods)

Importance of Data Collection - Types of Data - Data Collection Methods - Data Sources - primary, secondary and Big Data sources - Data Quality & Ethics - Tools and Technology for Data Collection.

UNIT-III: DATA ANALYSIS AND REPORTING (09 Periods)

Overview of Multivariate analysis - Experimental research, cause-effect relationship, and development of hypotheses- Measurement systems analysis, error propagation, and validity of experiments - Guidelines for writing abstracts, introductions, methodologies, results, and discussions - Writing Research Papers & proposals.

UNIT-IV: UNDERSTANDING INTELLECTUAL PROPERTY RIGHTS (09 periods)

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT-V: PATENTS (09 Periods)

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification - Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents

Total Periods: 45

Textbooks:

T1. Research Methodology: An introduction for Science & Engineering students, Stuart Melville and Wayne Goddard, Juta and Company Ltd, 2004
T2. Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Catherine J. Holland, Entrepreneur Press, 2007.

References Books:

R1. Business Research Methods, Cooper Donald R, Schindler Pamela S and Sharma JK, Tata McGraw Hill Education, 2012, Eleventh Edition,
R2. Research Methodology: A Step-by-Step Guide for Beginners, David Hunt, Long Nguyen, Matthew Rodgers, Wiley, 2007.
R3. Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, Deborah E. Bouchoux, Cengage, 2024, Sixth Edition,
R4. The Craft of Research, Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, University of Chicago Press, 2024, Fifth Edition.
R5. Professional Programme Intellectual Property Rights, Law and practice, The Institute of Company Secretaries of India, Statutory body under an Act of parliament, September, 2013.

Web Resources:

1. Research Methodology and Data Analysis courses, Coursera / edX
2. Latest journals on research design and statistics, Springer Link & ScienceDirect
3. Free access to research papers Google Scholar
4. Open-access research methodology resources, NCBI Bookshelf
5. For fundamentals of hypothesis testing, regression, and ANOVA. Khan Academy (Statistics & Probability)

2599181	M.Tech., I-SEMESTER ENGLISH FOR RESEARCH PAPER WRITING (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE-I)	L	T	P	C
		2	0	0	2

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Demonstrate proficiency in academic English by applying MAP principles, using clear, precise, and objective language, structuring coherent paragraphs, integrating references, and employing paraphrasing and appropriate tone in writing.

CO2. Exhibit critical reading skills to analyze academic texts, differentiate between article types, identify arguments and methodologies, evaluate findings, and make effective notes.

CO3. Apply advanced grammar and punctuation to construct clear, accurate, and complex sentences with proper voice, tense consistency, subject-verb agreement, and unambiguous references.

CO4. Revise and refine written work by editing for clarity, coherence, and grammar; proofread for accuracy; and apply effective strategies for professional correspondence and creative writing.

CO5. Demonstrate digital literacy by critically evaluating online content, using AI tools ethically in research writing, generating accurate citations, and practicing plagiarism-free writing with awareness of fair practices.

SYLLABUS:

UNIT-I: FUNDAMENTALS OF ACADEMIC ENGLISH (05 Periods)

Academic English - MAP (Message-Audience-Purpose) - Language Proficiency for Writing - Key Language Aspects - Clarity and Precision - Objectivity - Formal Tone - Integrating References - Word order - Sentences and Paragraphs - Link Words for Cohesion - Avoiding Redundancy / Repetition - Breaking up long sentences - Structuring Paragraphs - Paraphrasing Skills – Framing Title and Sub-headings

UNIT-II: READING SKILLS FOR RESEARCHERS (06 Periods)

Reading Academic Texts - Critical Reading Strategies - Skimming and Scanning - Primary Research Article vs. Review Article - Reading an Abstract - Analyzing Research Articles - Identifying Arguments - Classifying Methodologies - Evaluating Findings - Making Notes

UNIT-III: GRAMMAR REFINEMENT FOR RESEARCH WRITING (06 Periods)

Advanced Punctuation Usage - Grammar for Clarity - Complex Sentence Structures - Active-Passive Voice - Subject-Verb Agreement - Proper Use of Modifiers - Avoiding Ambiguous Pronoun References - Verb Tense Consistency - Conditional Sentences.

UNIT-IV: MASTERY IN REFINING WRITTEN CONTENT/EDITING SKILLS

(07 Periods)

Effective Revisions - Restructuring Paragraph - Editing vs Proofreading, Editing for Clarity and Coherence - Rectifying Sentence Structure Issues - Proofreading for Grammatical Precision – Spellings - Tips for Correspondence with Editors - Critical and Creative Phases of Writing.

UNIT-V: TECHNOLOGY AND LANGUAGE FOR RESEARCH (06 Periods)

Digital Literacy and Critical Evaluation of Online Content - Technology and Role of AI in Research Writing – Assistance in Generating Citations and References - Plagiarism and Ethical Considerations – Tools and Awareness – Fair Practices

Total Periods: 30

Textbooks:

T1. Bailey. S. Academic Writing: A Handbook for International Students. London and New York: Routledge,2015.

T2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Reference books:

R1. Craswell, G. *Writing for Academic Success,* Sage Publications, 2004.

R2. Peter Elbow, *Writing With Power, E-book*, Oxford University Press, 2007

R3. Oshima, A. & Hogue, A. *Writing Academic English*, Addison-Wesley, New York, 2005

R4. Swales, J. & C. Feak, Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press, 2012.

R5. Goldbort R.*Writing for Science*, Yale University Press (available on Google Books), 2006

R6. Day R.*How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006

Web Resources:

1. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge04/
2. https://onlinecourses.swayam2.ac.in/ntr24_ed15/preview
3. "Writing in the Sciences" – Stanford University (MOOC on Coursera) https://www.coursera.org/learn/sciwrite
4. Academic Phrasebank – University of Manchester http://www.phrasebank.manchester.ac.uk
5. OWL (Online Writing Lab) – Purdue University, https://owl.purdue.edu *(Resources on APA/MLA formats, grammar, structure, paraphrasing)*
6. Zotero or Mendeley (Reference Management Tools) – Useful for managing citations and sources.

2512181	M.Tech., I-SEMESTER DISASTER MANAGEMENT (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) (AUDIT COURSE - I)	L	T	P	C
		2	0	0	0

Pre-Requisites: Nil

COURSE OUT COMES:

On successful completion of the course, student will be able to

CO1. Identify and map disaster-prone areas and understand the epidemiological consequences of disasters.

CO2. Define and distinguish between hazards and disasters, and explain their types, nature, and impacts.

CO3. Assess the economic, social, and ecological repercussions of major natural and man-made disasters.

CO4. Apply risk assessment methods and propose disaster risk reduction strategies at local, national, and global levels.

CO5. Demonstrate knowledge of disaster preparedness tools such as remote sensing, meteorological data, risk evaluation, and community awareness.

SYLLABUS:

UNIT–I: INTRODUCTION (06 Periods)

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-II: REPERCUSSIONS OF DISASTERS AND HAZARDS (06 Periods)

Economic Damage - Loss of Human and Animal Life - Destruction of Ecosystem - Natural Disasters - Earthquakes, Volcanism, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster - Nuclear Reactor Meltdown - Industrial Accidents - Oil Slick sand Spills - Outbreaks of Disease and Epidemics War and Conflicts

UNIT-III: DISASTER PREPAREDNESS AND MANAGEMENT (06 Periods)

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-IV: RISK ASSESSMENT (06 Periods)

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's participation Risk Assessment – Strategies for Survival

UNIT-V: DISASTER MITIGATION (06 Periods)

Meaning, Concept and Strategies of Disaster Mitigation – Emerging Trendsin Mitigation - Structural Mitigation and Non- Structural Mitigation - Programs of Disaster Mitigation in India

Total Periods: 30

Textbooks:

T1. *Disaster Management*, Gupta, H. K, Universities Press, 2003
T2. Singh, R. B. *Natural Hazards and Disaster Management*. Rawat Publications, 2006.

Reference Books:

R1. Coppola, D. P. (2020).*Introduction to International Disaster Management* (4th ed.). Elsevier.
R2. Shaw, R., & Izumi, T. (2022).*Science and Technology in Disaster Risk Reduction in Asia*.Springer.
R3. Wisner, B., Gaillard, J. C., &Kelman, I. (2021).*Handbook of Hazards and Disaster Risk Reduction and Management* (2nd ed.). Routledge.
R4. Saini, V. K. (2021). *Disaster Management in India: Policy, Issues and Perspectives*. Sage India.
R5. Kelman, I.*Disaster by Choice: How Our Actions Turn Natural Hazards into Catastrophes,* Oxford University Press, 2022
R6. Sahni, P. &Dhameja, A.*Disaster Mitigation: Experiences and Reflections*. Prentice Hall of India, 2004.

Web Resources:

1. https://ndma.gov.in – official guidelines, reports, and policy frameworks.
2. https://www.undrr.org – Sendai Framework, global risk reduction strategies.
3. https://www.gdacs.org – real-time disaster alerts
4. https://www.undrr.org – Sendai Framework, global risk reduction strategies.

		L	T	P	C
2598181	**M.Tech., I-SEMESTER** **ESSENCE OF** **INDIAN TRADITIONAL KNOWLEDGE** (Common to AIDS, PS, Geo-Tech, RE, ES&VLSI) **(AUDIT COURSE - I)**	**2**	**0**	**0**	**2**

COURSE OUTCOMES:

On successful completion of the course, student will be able to

CO1. Illustrate traditional knowledge, its nature, characteristics, and scope

CO2. Demonstrate the need for protecting traditional knowledge and its significance in the global economy

CO3. Explain the legal framework and policies related to traditional knowledge protection

CO4. Apply traditional knowledge in different sectors, such as engineering, medicine, agriculture, and biotechnology

CO5. Analyze the importance of traditional knowledge in various contexts, including its historical impact and social change, relationship between traditional knowledge and intellectual property rights, including patents and non-IPR mechanisms

SYLLABUS:

UNIT-I: INTRODUCTION TO TRADITIONAL KNOWLEDGE (06 Periods)

Definition, Nature and characteristics, scope and importance - Kinds of traditional knowledge - Physical and social contexts in which traditional knowledge develop - Historical impact of social change on traditional knowledge systems - Indigenous Knowledge (IK) – Characteristics - traditional knowledge vis-à-vis indigenous knowledge -Traditional knowledge Vs western knowledge, traditional knowledge vis-à-vis formal knowledge

UNIT-II: PROTECTION OF TRADITIONAL KNOWLEDGE (06 Periods)

Need for protecting traditional knowledge - Significance of TK Protection - Value of TK in global economy - Role of Government to harness TK.

UNIT-III: **LEGAL FRAME WORK AND TRADITIONAL KNOWLEDGE (06 Periods)**

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 - Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act).

The Biological Diversity Act 2002 and Rules 2004 - the protection of traditional knowledge bill, 2016 Geographical Indicators Act 2003.

UNIT-IV: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY (06 Periods)

Systems of traditional knowledge protection - Legal concepts for the protection of traditional knowledge - Certain non-IPR mechanisms of traditional knowledge protection - Patents and traditional knowledge - Strategies to increase protection of traditional knowledge -Global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT-V: TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS (06 Periods)

Traditional knowledge and Engineering - Traditional medicine system - TK and Biotechnology - TK in Agriculture - Traditional societies depend on it for their food and healthcare needs - Importance of conservation and sustainable development of environment - Management of biodiversity, Food security of the country and protection of TK

Total Periods: 30

Textbooks:

T1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning Pvt. Ltd. Delhi, 2022 1st Edition.
T2. Basanta Kumar Mohanta and Vipin Kumar Singh, Traditional Knowledge System and Technology in India, Pratibha Prakashan 2012 1st Edition.

Reference Books

R1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi 2006.
R2. Kak, S.C. "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), 1987
R3. Subbarayappa, B.V. and Sarma, K.V. Indian Astronomy: A Source Book, Nehru Centre, Mumbai, 1985.
R4. Bag, A.K. History of Technology in India, Vol. I, Indian National Science Academy, New Delhi, 1997.
R5. Acarya, P.K. Indian Architecture, Munshiram Manoharlal Publishers, New Delhi, 1996.
R6. Banerjea, P. Public Administration in Ancient India, Macmillan, London, 1961.
R7. Kapoor Kapil, Singh Avadhesh, Indian Knowledge Systems Vol – I & II, Indian Institute of Advanced Study, Shimla, H.P., 2022

Web Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/12110600

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