

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES RAJAMPET**

**(An Autonomous Institution)**

**ACADEMIC REGULATIONS (R19), COURSE STRUCTURE AND SYLLABI**

**For the students admitted to**

**M. Tech., Regular Two Year Degree Programme from the Academic Year 2019-20**

**VISION AND MISSION OF THE INSTITUTION**

**Vision**

We impart futuristic technical education and instil high patterns of discipline through our dedicated staff who set global standards, making our students technologically superior and ethically strong, who in turn shall improve the quality of life of the human race.

**Mission**

Our mission is to educate students from the local and rural areas and from other states so that they become enlightened individuals, improving the living standards of their families, industry and society. We provide individual attention, world-class quality of Technical education and take care of character building.

**ACADEMIC RULES AND REGULATIONS OF TWO -YEAR M. TECH REGULAR DEGREE PROGRAMME**

**APPLICABLE FOR THE STUDENT BATCHES ADMITTED FROM THE ACADEMIC YEAR 2019-20**

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**1. PREAMBLE**

Annamacharya Institute of Technology and Sciences (Autonomous), Rajampet, relentlessly aims to achieve academic excellence by implementing new initiatives in teaching-learning and evaluation processes. Based on the directions of the University Grants Commission (UGC), New Delhi, All India Council for Technical Education (AICTE), New Delhi and Jawaharlal Nehru Technological University Anantapur (JNTUA) Anantapuramu, the institute adopted AICTE model curriculum, with minor modifications to match the needs, expectations, and skillsets of students of the region, in the post-graduate programmes offered from the academic year 2019-20.

**2. APPLICATION AND COMMENCEMENT**

* The regulations are quite comprehensive and include definitions of key terms, semester system, credit system, grading system and other relevant details.
* The regulations detailed herein shall apply to all the regular post-graduate programmes offered by the Institute.
* The regulations shall be applicable and come into force to the student batches admitted from the academic year 2019-20
* The Institute may revise, amend or change the regulations, scheme of examinations and syllabi, from time to time, if found necessary and on approval by the Academic Council of the Institute, keeping the recommendations of the Board of Studies in view.
* Any or all such amendments shall be effective from such date and to such batches of students including those already undergoing the programme, as may be approved through Academic Council of the Institute.
* These regulations shall be called R19 Regulations.

**3. PROGRAMMES OFFERED BY THE INSTITUTE**

The following M. Tech. programmes are offered as specializations by the Institute from 2019-2020.

|  |  |  |
| --- | --- | --- |
| **SNo** | **Name of the Program** | **Programme Code** |
| 1 | Structural Engineering | 1 |
| 2 | Electrical Power Systems | 2 |
| 3 | Machine Design | 3 |
| 4 | Embedded Systems | 4 |
| 5 | Computer Science and Engineering  E | 5 |

**4. ELIGIBILITY FOR ADMISSION**

The eligibility criteria for admission into engineering Post Graduate programmes offered at AITS shall be as prescribed by the Government of Andhra Pradesh. The criteria are given below:

* Admission to the above programmes shall be made subject to the eligibility and qualifications as prescribed from time to time.
* Admissions shall be made on the basis of Rank / Percentile earned by the candidate in the relevant GATE examination / merit rank obtained by the qualifying candidate in the entrance test (PGECET) conducted by the Government of Andhra Pradesh for M.Tech. programmes or as decided by APSCHE subject to the reservations as prescribed by the university / State Government / on the basis of any other order of merit as decided by APSCHE from time to time
* Seats in each programme in the Institute are classified into two categories i.e., **Category – A** and **Category – B** as per the GOs of Andhra Pradesh.

**Category – A Seats**

These seats shall be filled through counselling as per the rank secured by a candidate in the Common Entrance Test (PGECET) conducted by the Government of Andhra Pradesh and as per other admission criteria laid down in the GOs.

**Category – B Seats**

These seats shall be filled by the Institute as per the GOs issued by the Government of Andhra Pradesh from time to time

**5. MEDIUM OF INSTRUCTION**

The medium of instruction shall be **English** for all the courses including their content delivery and examinations, seminars, presentations and project evaluation as prescribed in the programme curriculum.

**6. M.TECH. PROGRAMME STRUCTURE**

The structure of the M.Tech. Programmes on offer at AITS are based on the **Choice Based Credit System (CBCS)** as defined by the UGC and the curriculum / course structure as suggested by the AICTE in its Model Curriculum.

**Semester Scheme**

* The M. Tech Programmes offered at AITS follow **semester scheme** pattern.
* The duration of a M. Tech. Programme shall be of 2 **academic** years**.**
* Each academic year shall have **2 semesters** i.e., odd and even semesters and shall be counted as first semester, second semester, and so on up to fourth semester.
* Each semester shall consist of **16 weeks** of academic work excluding internal examinations.
* Each semester is structured to provide credits totalling to **68 credits** for the entire M.Tech. Programme.
* Each semester shall have **Continuous Internal Evaluation (CIE)** and **Semester End** **Examination (SEE)** for both Theory and Lab courses.
* A student after securing admission into a 2 year M.Tech Programme at AITS shall pursue and acquire the M.Tech. Degree in a **minimum period of two academic years i.e., 4 semesters** and a **maximum period of four academic years i.e., 8 semesters** starting from the date of commencement of I year I semester, failing which the student shall forfeit the seat in M.Tech. Programme.

**7. COURSES AND CREDIT STRUCTURE**

**Credit:** A credit is 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/project per week.

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

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

Each course is assigned certain number of credits based on following criterion

|  |  |  |
| --- | --- | --- |
| Type of Class | Semester | |
| Periods per Week | Credits |
| Theory  (Lecture/Tutorial) | 01 | 01 |
| 02 | 02 |
| 03 | 03 |
| 04 | 04 |
| Practical | 02 | 01 |
| 03 | 1.5 |
| 04 | 02 |
| Project Work Stage 1 | - | 10 |
| Project Work Stage 2 | - | 16 |

Every course of the M. Tech. programme shall be offered by a specific section / department. The

unique codes of the section / department offering the courses are given in the Table.

|  |  |
| --- | --- |
| **Course offering Department** | **Code** |
| Basic Science Courses | C |
| Humanities Courses |
| Management Courses | E |
| Civil Engineering | 1 |
| Electrical and Electronics Engineering | 2 |
| Mechanical Engineering | 3 |
| Electronics & Communication Engineering | 4 |
| Computer Science & Engineering | 5 |

Every M. Tech. Programme of study shall be designed to have theory and laboratory courses. In addition, a student shall carry out project phase-1, project phase-2, other mandatory courses and audit courses as prescribed in the curriculum of the Programmes.

**7.1 Types of Courses:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type of courses | Course category | Code | Range of credits | | | | | |
| SE | EPS | MD | ES | CSE | |
| Compulsory courses | Professional Core | PC | 12 | 12 | 12 | 12 | 12 | |
| Project / Dissertation Work | PW | 26 | 26 | 26 | 26 | 26 | |
| Mini-Project with Seminar | PS | 2 | 2 | 2 | 2 | 2 | |
| Laboratory Courses | PL | 8 | 8 | 8 | 8 | 8 | |
| Elective courses | Professional Electives | PE | 15 | 15 | 15 | 15 | 15 | |
| Open Elective | OE | 3 | 3 | 3 | 3 | 3 | |
| Mandatory Learning Course | | MLC | 2 | 2 | 2 | 2 | | 2 |
| Audit Course | Audit Course | AU | Non-Credit | | | | | |

**7.1.1 Foundation Courses**

Engineering Science courses, Basic Science Courses and Humanities courses are termed as Foundation Courses and are mostly offered at I and II Year.

**7.1.2 Professional Core Courses**

Professional Core Course is to be completed by all students of respective programme before they can move on to the next semester.

**7.1.3 Professional Core Electives**

University Grants Commission has come up with the Choice Based Credit System (CBCS) in which the students have a choice to choose from the prescribed courses, which are referred as Professional elective and Open Elective courses.

Students have to register for a total of 5 professional core electives courses (PE-1 to PE-5) from the list of track-wise professional elective course as prescribed in the course structure of the programme. The following points are considered for a Professional Elective Course.

* The selection of course based on the choice for students shall be on ‘first come first serve’ through on line and off line registration.
* The Head of the department or concerned shall decide, whether or not to offer such course keeping in view the resources available in the department offering the course.

**7.1.4 Open Electives**

Choice Based Credit System (CBCS) is promoted in such a way that different open elective courses should be offered by every department in engineering to other departments. This interdisciplinary of learning open elective courses by other department students will have learning awareness and job-oriented benefits. Students require the opportunity to choose any open elective course from different departments and apply their knowledge to acquire jobs in that field of course. Learning and employment benefits are not only through their own course subjects but also through open elective courses.

Every student shall earn prescribed credits by choosing one of the open elective courses from the list of Open Electives given in the Curriculum. Further students from a particular program/branch can opt for one Open Elective (OE1) offered by their concerned department. However, two Open Electives are inter-disciplinary and shall be offered by other branches.

**8. EVALUATION PROCESS**

The performance of a student in each semester shall be evaluated course-wise with a maximum of 100 marks for both Theory and Lab Courses.

* For a Theory course, the distribution shall be 40 marks for Internal Evaluation and 60 marks for End-Examinations. The distribution is detailed in 8.1.1.
* For a Lab course, the distribution shall be 40 marks for Internal Evaluation and 60 marks End- Examinations. The distribution is detailed in 8.1.2
* For a mini-project with seminar course shall be evaluated for 100 marks, the evaluation procedure is detailed in 8.1.3
* For Audit Course, the evaluation procedure is detailed in 8.1.4
* For the project work, the evaluation procedure is detailed in 9.0

**8.1 Internal Evaluation**

**8.1.1 Theory Internal Examinations**

For a Theory Course, 40 marks are allotted for Internal Evaluation. Two mid-term examinations (Theory Internal Examinations) shall be conducted for a Theory Course during a semester and they shall be evaluated for 30 marks. Remaining 10 marks is for continuous evaluation which includes weekly/ fortnightly class tests, homework assignments, problem solving, group discussions, quiz, seminar, mini-project and other means. The method of allotting these marks will be decided by the teacher dealing that subject in consultation with the Head of the Department. Teacher has to announce the evaluation method in the beginning of the semester. First midterm examination shall be conducted as per the syllabus of I & II units. The second midterm examination shall be conducted as per the syllabus of III, IV and V units.

Note: Final Internal marks for a total of 30 marks shall be arrived at by considering the best marks secured by the student in both the internal examinations

**8.1.2 Laboratory Internal Examinations**

For Lab Course, there shall be a continuous internal evaluation during the semester for 40 marks. Out of the 40 marks, day-to-day performance of the student in the laboratory shall be evaluated for 30 marks by the concerned laboratory teacher based on experimental correctness/record/viva. Two Lab Internal examinations shall be conducted for 10 marks by the concerned teacher. Performance of one best out of two tests to be considered.

**8.1.3 Mini-project with Seminar**

* A student shall undergo a mini-project with seminar during the I year II Semester of the M.Tech Programme
* A student under the supervision of a faculty member, shall collect literature on an allotted project topic of his/her choice, critically review the literature, carry out the mini-project and submit it to the department in a form of report as prescribed the Academic section and shall make an oral presentation before the Departmental Project Review Committee.
* Evaluation of the mini-project shall consist of Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) and shall be done by a Departmental Committee (DC) consisting of the Head of the Department, faculty supervisor and a senior faculty member of the specialization / department for a total of 100 marks.
* CIE shall be carried out for 40 marks on the basis of review presentation as per the academic calendar and evaluation format provided by Academic Section.
* SEE shall be carried out at the end of semester for 60 marks on the basis of an oral presentation and submission of mini-project report after clearing the plagiarism check.
* A student has to secure a minimum of 50 % marks to be declared successful.
* Prior to the submission of mini-project report to the DC, its soft copy shall be submitted to the Research and Development Cell for PLAGIARISM check.
* The mini-project report shall be accepted for submission to the DC, if the similarity index is less than 30%. If the similarity index is more than the required percentage, the student shall be advised to modify the content accordingly and re-submit the soft copy of the report after one week.
* The maximum number of re-submissions of mini-project report after plagiarism check is limited to TWO. After this, the student shall be deemed to secure ‘Fail’ grade in the mini-project and shall re-register for it in the next semester.

**8.1.4 Internal Evaluations of Audit Courses**

* A student shall pursue Audit courses as specified in the course structure of the M.Tech. Programme.
* These courses are among the compulsory courses and do not carry any credits.
* A student has to secure 50 marks out of 100 in the Internal Examination, shall be necessary requirement for the student to qualify for the **award of Degree**.
* Result of mandatory courses shall be declared with **“Pass”** or **“Fail”** performance in the Comprehensive Marks Memo.
* No marks or letter grade shall be allotted.
* Attendance in the Audit course shall be considered while calculating aggregate attendance.

**8.2 End Evaluation**

**8.2.1 Theory End Examinations**

As specified in 8.0, Theory End Evaluation is done for 60 marks. End examination of theory subjects shall be conducted at the end of semester. There shall be Regular and Supplementary End Examinations. Theory End Examination shall be conducted for 60 marks and is of 3 hours duration. The question paper shall be of subjective type with 5 questions, one question from each unit, with internal choice. All questions carry equal marks of 12 each.

**8.2.2 Laboratory End Examinations**

As specified in 8.0, Lab End Evaluation is done for 60 marks, in the form a Lab End Examination that shall be conducted for 3 hours in respective Laboratory. Each lab course will have its own evaluation procedure and weightage.

**8.2.3 Evaluation of Mandatory Learning Courses**

Mandatory Learning Course (Research Methodology and IPR) is offered with 2 credits. For a Theory course, the distribution shall be 40 marks for Internal Evaluation and 60 marks for End-Examinations. For internal evaluation and external evaluation refer 8.1.1 and 8.2.1 respectively.

**8.2.4 Supplementary Theory/Laboratory End Examinations**

* Supplementary examination shall be conducted along with regular semester end examinations.
* During Semester End Examinations of even semester, supplementary examinations of odd semester shall be conducted and during semester end examinations of odd semester, supplementary examinations of even semester shall be conducted.
* The same schedule is applicable to Supplementary Lab End Examinations. Supplementary examination shall be conducted along with the next batch of students or separately.
* In case of seminars and comprehensive viva-voce examinations, supplementary seminar / comprehensive viva-voce will be conducted along with the next batch of students. If the next batch of students is not available, a separate supplementary examination will be conducted.

**8.2.5 Revaluation and Recounting**

Students may visit Examination Section Webpage for Norms and Procedures for Revaluation and Recounting of Answer Scripts.

* The students who wishes to apply for Revaluation/Recounting of his/her answer-books(s) must submit his/her application on the prescribed form together with the requisite fee to the Controller of Examinations before expiry of 15 days excluding the date of the declaration of his/her examination result. Application not received in the prescribed form or by the due date or without the requisite fee shall be rejected.
* After Recounting / Revaluation, records are updated with changes if any and the student will be issued a revised memorandum of marks. If there are no changes, the student shall be intimated the same through a notice.
* No Revaluation / Recounting for Laboratory Examination.
* The students are informed to be more careful in furnishing the information while applying for Recounting / Revaluation. The applications with insufficient information will be summarily rejected and the student has to forfeit the amount paid in this connection.

**8.2.6 Challenge Evaluation**

* Applications are invited from the students, who wish to apply for Challenge Valuation in the subjects of the M.Tech Regular and Supplementary examinations
* The student will apply for Challenge valuation in a specified application and should be routed through the HOD concerned.
* The students who have applied for the revaluation for a paper(s) of an examination are only eligible for the Challenge Valuation of that paper(s) of that examination.
* A Fee of Rs. 10000/- (Ten Thousand Rupees Only) for each paper is to be paid within the last date for challenge valuation.
* A Xerox copy of the answer script will be provided to the student on receipt of the payment of fee and date and time of the valuation will be informed to the student, so that valuation will be done in the presence of the teacher attended in support of the student nominated by the HOD concerned.
* The HOD concerned will nominate a teacher of the concerned subject to observe the valuation in support of the student. This will be done on the request of the student.
* If the marks obtained in the challenge valuation are more than or equal to 15% of the maximum marks with respect to the original marks obtained in the first valuation, then the marks obtained in the Challenge valuation will be awarded to the student and the institute will pay back Rs 9,000 (Nine thousands rupees only) to the student. If the student status changes from fail to pass, an amount of Rs. 5000 will be refunded to the student. Otherwise there will not be any change in the result of the student and original marks will be retained and the student will forfeit the fee paid.
* No Challenge valuation for Laboratory Examination

**9.0 PROJECT EVALUATION**

Every student shall be required to submit thesis/dissertation after taking up a topic approved by the Departmental Committee

* The Departmental Committee (DC) consisting of HOD, Project supervisor and two internal senior experts shall monitor the progress of the project work. A project Review committee (PRC) shall be constituted with Principal as a Chair person, Heads of the Departments of the M.Tech programs and two other senior faculty members, as members of PRC. PRC will come into action when DC is not able to resolve the issues.
* Registration of project work: A student is permitted to register for the project work after satisfying the attendance requirements of all the courses (theory, practical and seminars )
* After satisfying above point, a student has to submit in consultation with his supervisor, the title, objective plan of action of his project work to the DC for approval. Only after obtaining the approval of DC, the student can initiate the project work
* The work on the project shall be initiated in the penultimate semester and continued in the final semester. The duration of the project is for two semesters. The student can submit project thesis with the approval of DC after 36 weeks from the date of registration at the earliest but not later than one calendar year from the date of registration for the project work. Extension of time within the total permissible limit for completing the programme is to be obtained from the Head of the Institute
* The internal evaluation shall be made by the DC to grade, on the basis of two seminars presented by the student on the topic of his project.
* The student must submit the status of thesis/dissertation only after passing all the prescribed subjects such as theory, practical’s, seminar and project internal evaluation
* A Student has to prepare four copies of the thesis/dissertation certified in the prescribed format by the supervisor and HOD. Out of which three copies shall be submitted in the examination section.
* Viva Voce examination shall be conducted by a board consisting of the supervisor, Head of the department and the External examiner. The Board shall jointly report student work as:

1. Outstanding
2. Very Good
3. Good
4. Satisfactory
5. Not Satisfactory

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce.

* If the report of the viva-voce is failure, the student will retake the viva-voce examination after three months. If he/she fails to get a satisfactory report at the second viva-voce examination, he/she will not be eligible for the award of the degree.

**10. ATTENDANCE REQUIREMENTS AND DETENTION POLICY**

* A student shall maintain a minimum required attendance of 75% in AGGREGATE.
* Shortage of attendance up to 10% i.e., attendance between 65% to 75% in aggregate, may be condoned by the Institute Academic Committee based on the rules prescribed by the Academic Council of the Institute from time to time.
* A stipulated fee shall be payable towards condonation of shortage of attendance.
* Shortage of attendance below 65 % shall in no case be condoned. A stipulated fee shall be payable towards condonation of shortage of attendance to the Institute as per following slab system

**1stSlab:** Less than 75% attendance but equal to or greater than 70% a normal condonation fee can be collected from the student.

**2ndSlab**: Less than 70% but equal to or greater than 65%, double the condonation fee can be collected from the student.

* Students whose shortage of attendance is not condoned OR who have not paid the stipulated fee OR who have not cleared any other due to the Institute in any semester are not eligible to write the Semester End Examination (SEE).
* Students, who do not meet the minimum required attendance of 65% in a semester, shall be detained in that semester and their registration for that semester shall stand cancelled. They shall not be promoted to the next semester.
* Students detained in a semester shall seek re-admission into that semester as and when offered.
* Academic regulations applicable to the semester in which re-admission is sought shall be applicable to the re-admitted student.
* In case, there are any professional electives and /or open electives, the same may also be re- registered, if offered. However, if those electives are not offered in the later semesters, then alternate electives may be chosen from the same set of elective courses offered under that category.

Any student against whom any disciplinary action is pending shall not be permitted to attend semester end examination (SEE) in that semester.

**11. Minimum Academic Requirements and Award of the Degree**

The following Academic Requirementshave to be satisfied in addition to the attendance requirements mentioned in section 10.

**11.1** A student shall be deemed to have satisfied the minimum academic requirements and earn the credits for each theory or practical and Audit courses and Research methodology and Intellectual Property Rights course, if he secures

* A minimum of 40 % marks for each theory course in the Semester End Examination (SEE), and
* A minimum of 50 % marks for each theory course considering both CIE and SEE taken together.

**11.2** A student shall be deemed to have satisfied the minimum academic requirements and earn the credits allotted to mini-project courses, if he secures

* A minimum of 50 % marks for mini-project with seminar in the Continuous Internal Evaluation (CIE)

**11.3** A student shall be treated as failed, if he

* Does not submit a report of mini-project with seminar and report of project phase courses OR
* Does not make a presentation of the same before the evaluation committee as per the schedule, or
* Secures less than 50 % marks in evaluation.

**11.4** If a student fails to secure a pass grade in a particular course, it is mandatory that he shall register and re-appear for the examination in that course during the next semester when SEE is conducted in that course. It is mandatory that he should continue to register and re-appear for the examination till he secures a pass grade.

**11.5** A student detained in a SEMESTER due to shortage of attendance, may be re-admitted when the same semester in the next academic year for fulfillment of academic requirements.

**11.6** Academic regulations applicable to the semester in which re-admission is sought shall be applicable to the re-admitted student.

**11.7** A student shall be given one chance to re-register, after completion of the course work, for each course, provided the internal marks (CIE) secured by a student are less than 50% and he has failed in the SEE. In such a case, a student may re-register for the course(s) with prior permission and secure the minimum required attendance. Attendance in the re-registered course(s) shall be calculated separately to become eligible to write the semester end examination (SEE) in the re-registered course(s).

**11.8** Re-registration is allowed only in those cases where the student doesn’t have any course(s) yet to pass other than the re-registration course(s) where the CIE marks are less than 50%. However, in the case of re-registration of course(s) by a student, academic regulations applicable at the time of student admission in the programme shall be applicable.

**11.9 In** the event of re-registration, the internal evaluation marks as well as the End Semester Examinations marks secured in the previous attempt (s) for those subjects stand cancelled.

**11.10** For each subject re-registered, the student has to pay a fee equivalent to one third of the semester tuition fee

**11.11** A student shall register and put up minimum academic requirement of all 68 credits and earn all 68 credits for the award of M. Tech degree

**11.12** Students who fail to earn 68 credits as indicated in the course structure within four academic years from the year of their admission shall forfeit their seat in M. Tech. course and their admission shall stand cancelled.

**12. SEMESTER GRADE POINT AVERAGE (SGPA) AND CUMULATIVE GRADE POINT AVERAGE (CGPA)**

The performances of students in each of the courses in the Programme are expressed in terms of letter grades based on an absolute grading system. We use 10-point grading system with letter grades. They are given in the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Marks Obtained** | **Letter Grade** | **Description** | **Grade Points**  **(GP)** |
| ≥90 | S | Superior | 10 |
| ≥80 and ≤89.99 | E | Excellent | 9 |
| ≥70 and ≤79.99 | A | Very Good | 8 |
| ≥60 and ≤69.99 | B | Good | 7 |
| ≥50 and ≤59.99 | C | Average | 6 |
| ≥40 and ≤49.99 | D | Pass | 5 |
| ≤40 | F | Fail | -- |
| Absent in the exam(s) | AB | Absent | -- |

A student is eligible for the award of the M.Tech. Degree with the class as mentioned in the following table

|  |  |
| --- | --- |
| **CGPA** | **Class** |
| ≥7.5 | First class with Distinction |
| ≥6.5 and <7.5 | First Class |
| ≥5.5 and <6.5 | Second Class |
| ≥5.0 and <5.5 | Pass |

For mandatory courses, student shall be awarded “pass” or “fail “without any credit. This shall not be counted for the computation of SGPA/CGPA

**12.1 Computation of SGPA**

The performance of each student at the end of each semester shall be indicated in terms of SGPA. The

SGPA shall be calculated as follows:

Where

= Number of credits allotted to a particular curse ‘i’

= Grade point corresponding to the letter grade awarded to the course i

,2,….p represent the number of courses in a particular semester.

Note: SGPA is calculated and awarded to those students who pass all the courses in a semester.

**12.2 Computation of CGPA**

The performance of a student shall be obtained by calculating Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained on all courses during the course of study

Where

= Number of credits allotted to a particular semester ‘j’

= Grade point corresponding to the letter grade awarded to the semester j

,2,….m represent the number of semester of the entire programme.

**12.3 Grade Card**

The grade card issued shall contain the following

* The credits for each course offered in that semester
* The letter grade and grade point awarded in each course
* The SGPA and CGPA
* Total number of credits earned by the student up to the end of that semester

Example: - Computation /calculation of SGPA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Course name | Credits  (C) | Letter grade | Grade point  (GP) | Credit point  (CP=C\*GP) |
| Course 1 | 4 | A | 9 | 4x9=36 |
| Course 2 | 3 | S | 10 | 3\*10=30 |
| Course 3 | 2.5 | S | 10 | 2.5\*10=25 |
| Course 4 | 1.5 | C | 6 | 1.5\*6=9 |
| Course 5 | 1 | D | 5 | 1\*5=5 |
| Total | 12 |  | | 105 |

Therefore, SGPA= 8.75

Example Illustration of CGPA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Semester 1 | Semester 2 | Semester 3 | Semester 4 | Semester 5 |
| Credit: 20  SGPA : 8.75 | Credit : 20  SGPA : 8.25 | Credit : 22  SGPA : 7.89 | Credit: 23  SGPA : 8.21 | Credit : 22  SGPA : 7.86 |

Thus, CGPA =

Similarly, compute CGPA obtained at the end of 4th semester shall be the final CGPA secured by the student for the entire programme.

**12.4 Conversion of SGPA into percentage**

In case of a specific query by students/employers regarding Semester Grade Point Average (SGPA)/ Cumulative Grade Point Average (CGPA) into percentage, the following formulae will be adopted for notional conversion of CGPA into percentage.

Percentage = 9.5 \* CGPA

**13. TRANSCRIPTS**

After successful completion of the entire programme of study, a transcript containing performance of all academic years will be issued as a final record. Duplicate transcripts will also be issued, if required, after payment of requisite fee. Partial transcript will also be issued up to any point of study to a student on request.

**14. 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 subjects as and when subjects are offered, subject to Section 11 and they will follow the academic regulations into which they are readmitted. Students who are permitted to avail gap year shall be eligible for re-joining into the succeeding year of their M.Tech from the date of commencement of class work, subject to Section 11 and they will follow the academic regulations into which they are readmitted.

**15. MINIMUM INSTRUCTION DAYS FOR A SEMESTER**

The minimum instruction days for each semester shall be 16 weeks.

**16. STUDENT TRANSFERS**

Student transfers shall be as per the guidelines issued by the Government of Andhra Pradesh and the affiliating University from time to time.

**17. ANNOUNCEMENT OF RESULTS**

* Results review committee comprising of University nominee, Principal, Dean Academics, Chairman of various boards of studies, Controller of Examinations and Deputy Controller of Examinations will monitor the results and gives the permission for announcement of results.
* After review meeting results are loaded in to Institution website from which students can access their results by entering Hall Ticket number. And also results in form of hard copy are available with respective Heads of the departments.

**18. GENERAL INSTRUCTIONS:**

* The academic regulations should be read as a whole for purpose of any interpretation.
* Malpractices rules-nature and punishments are appended.
* Where the words "he", "him", "his", occur in the regulations, they also include "she", "her", "hers", respectively.
* In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal / Governing body is final.
* Any legal issues are to be resolved in Rajampet Jurisdiction.
* The Institute 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 Institute.

**APPENDIX I: Rules for Disciplinary Action for Malpractices / Improper Conduct in Examinations**

**Malpractices identified by squad or special invigilators or invigilators**

Punishments shall be given to the students as per the above guidelines. The case is to be referred to the malpractice committee.

**Malpractice committee**

1. The Principal, Chairman

2. Dean, Academics, Member

3. Invigilator, Member

4. Subject expert, Member

5. Concerned Head of the Department, Member

6. Controller of Examinations, Member Secretary

**Note:**

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

|  |  |  |
| --- | --- | --- |
|  | **Nature of Malpractices/Improper conduct** | **Punishment** |
|  | *If the candidate:* |  |
| 1.(a) | Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination) | Expulsion from the examination hall and cancellation of the performance in that subject only. |
| (b) | Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter. | Expulsion from the examination hall and cancellation of performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him. |
| 2. | Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The Hall Ticket of the candidate is to be cancelled and sent  to the University. |
| 3. | Impersonates any other candidate in connection with the examination. | The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred 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 subjects of the examination (including practical’s and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for four consecutive semesters from class work and all University examinations, if his 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 subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 5. | Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks. | Cancellation of the performance in that subject 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 of the examination. | In case of student of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. 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. |
| 7. | Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall. | Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. |
| 8. | Possess any lethal weapon or firearm in the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. |
| 9. | If students of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in nay malpractice or improper conduct mentioned in class 6 to 8. | Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person (s) who does not belong to the College will be handed over to police and, a police case will be registered against them. |
| 10. | Comes in a drunken condition to the examination hall. | Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. |
| 11. | Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny. | Cancellation of the performance in that subject only or in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester / year examinations, depending on the recommendation of the committee. |
| 12. | If any malpractice is detected which is not covered in the above clauses 1 to 12 shall be reported to the University for further action to award suitable punishment. | |

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET: RAJAMPET (AUTONOMOUS)**

**R-19 ELECTRICAL POWER SYSTEMS COURSE STRUCTURE**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Semester-I | | | | | | | |
| SNo | Core/  Elective | Subject  Code | Course Name | Hours per Week | | | C |
| L | T | P |
| 1. | PC | 19B211T | Advanced Power System Analysis | 3 | 0 | 0 | 3 |
| 2. | PC | 19B212T | Advanced Power System Protection | 3 | 0 | 0 | 3 |
| 3. | PE | 19B21AT | HVDC Transmission | 3 | 0 | 0 | 3 |
| 19B21BT | Wind and Solar Systems |
| 19B21CT | Restructured Power Systems. |
| 19B21DT | Modern Control Theory |
| 4. | PE | 19B21ET | Electrical Power Distribution System | 3 | 0 | 0 | 3 |
| 19B21FT | Reactive Power Compensation and Management |
| 19B21GT | Mathematical Methods for Power  Engineering |
| 19B21HT | Hybrid Electric Vehicles |
| 5. | MC | 19BE11T | Research Methodology and IPR | 2 | 0 | 0 | 2 |
| 6. | PL | 19B211L | Power system Simulation lab-1 | 0 | 0 | 4 | 2 |
| 7. | PL | 19B212L | Power System Protection lab | 0 | 0 | 4 | 2 |
| 8. | AU | 19B113T | Disaster Management | 2 | 0 | 0 | 0 |
|  |  |  | Total Credits |  |  |  | 18 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Semester II | | | | | | | |
| SNo | Core/  Elective | Subject  Code | Course Name | Hours per week | | | C |
| L | T | P |
| 1. | PC | 19B221T | EHV AC Transmission | 3 | 0 | 0 | 3 |
| 2. | PC | 19B222T | Power System Control & Stability | 3 | 0 | 0 | 3 |
| 3. | PE | 19B22AT | Smart Grid Technologies | 3 | 0 | 0 | 3 |
| 19B22BT | Economic operation of Power Systems |
| 19B22CT | Swarm Intelligence Techniques in Power Systems |
| 19B22DT | Industrial Load Modelling and Control |
| 4. | PE | 19B22ET | AI Techniques in Power Systems | 3 | 0 | 0 | 3 |
| 19B22FT | Power Quality |
| 19B22GT | Power Apparatus Design |
| 19B22HT | Dynamics in Linear Systems |
| 5. | MC | 19B223P | Mini Project with Seminar | 0 | 0 | 4 | 2 |
| 6. | PL | 19B221L | Power system Simulation lab II | 0 | 0 | 4 | 2 |
| 7. | PL | 19B222L | Advanced Power Systems Lab | 0 | 0 | 4 | 2 |
| 8. | AU | 19BC21T | Academic and Research Report writing | 2 | 0 | 0 | 0 |
|  |  |  | Total Credits |  |  |  | 18 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Semester III | | | | | | | |
| SNo | Core/  Elective | Subject  Code | Course Name | Hours per week | | | C |
| L | T | P |
| 1 | PE | 19B23BT | Flexible AC Transmission Systems | 3 | 0 | 0 | 3 |
| 19B23CT | Gas Insulated Systems |
| 19B23DT | Energy Storage Technologies |
| 2. | OE | 19B53DT | Business Analytics | 3 | 0 | 0 | 3 |
| 19B13ET | Industrial Safety |
| 19B3BDT | Operations Research |
| 19BE3AT | Cost Management of Engineering Projects |
| 19B33ET | Composite Materials |
| 19B43DT | Wireless Communications |
| 19B23ET | Energy Conversion Systems |
| 3. | PW Project | 19B231P | Phase-I Dissertation | 0 | 0 | 20 | 10 |
|  |  |  | Total Credits |  |  |  | 16 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Semester IV | | | | | | | |
| SNo | Core/Elective | Subject  Code | Course Name | L | T | P | C |
| 1. | PW | 19B241P | Phase-II Dissertation | 0 | 0 | 32 | 16 |
|  |  |  | Total Credits |  |  |  | 16 |

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**ADVANCED POWER SYSTEM ANALYSIS**

**(19B211T)**

**M.Tech EPS, I Sem L T P C**

**3 0 0 3**

**Prerequisite: Computer Methods in Power Systems**

**Course Objectives**

1. To introduce different techniques of dealing with sparse matrix for large scale power systems.
2. To impart in-depth knowledge on different methods of power flow solutions.
3. To perform optimal power flow solutions in detail
4. To perform short circuit fault analysis and understand the consequence of different type of faults.
5. To Illustrate different numeric al integration methods and factors influencing transient stability

**Course Outcomes**: Students will be able to:

1. Understand different techniques dealing with sparse matrix for large scale power systems
2. Analyze different methods of power flow solutions.
3. Analyze various types of short circuit faults.
4. Understand to solve optimal power flow problem
5. Demonstrate different numeric al integration methods and factors influencing transient stability

**UNIT I:** SOLUTION TECHNIQUE Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays –Gauss elimination methods, Π- representation of off-nominal tap transformers.

**UNIT-II**: POWER FLOW STUDIES Introduction to load flow analysis, formation of Ybus . Classification of buses, Load flow solution methods – Gauss-Seidal method, Newton Raphson method, Decoupled and fast decoupled load flow, Comparison of load flow methods.

**UNIT-III:** SHORT CIRCUIT ANALYSIS: Formation of bus impedance matrix with & without mutual coupling (single phase basis) - Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase.

**UNIT IV** OPTIMAL POWER FLOW : Problem statement; Solution of Optimal Power Flow (OPF) – The gradient method, Newton’s method, Linear Sensitivity Analysis.

**UNIT-V**: NUMERICAL INTEGRATION METHODS: Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and Multi-machine system with classical synchronous machine model; Factors influencing transient Stability.

**TEXT BOOKS:**

1. J.J. Grainger &W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2003.
2. R. Bergen & Vijay Vittal , “Power System Analysis” ,Pearson , 2000.
3. Pai, M.A., „Computer Techniques in Power System Analysis‟, Tata McGraw hill, New Delhi, 2006

**REFERENCES:**

1. L.P. Singh ,“Advanced Power System Analysis and Dynamics”, New Age International, 2006.

2. G.L. Kusic, “Computer aided power system analysis” ,Prentice Hall India, 1986.

3. A.J. Wood, “ Power generation, operation and control” , John Wiley, 1994.

4. P.M. Anderson, “Faulted power system analysis” , IEEE Press , 1999

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**ADVANCED POWER SYSTEM PROTECTION**

**(19B212T)**

**M.Tech EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Power System Protection**

**Course Objectives:** Students will be able to:

1. Study of numerical relays & static relays.
2. Developing mathematical approach towards protection.
3. Study of algorithms for numerical protection.

**Course Outcomes:** Students will be able to:

1. Learn the importance of Digital Relays& static relays.
2. Apply Mathematical approach towards protection.
3. Learn to develop various Protection algorithms.

**UNIT-I:** Static Relays

Advantages of static relays-Basic construction of static relays-Replica impedance –Mixing circuits-General equation for two input phase and amplitude comparators Duality between amplitude and phase comparators.

Amplitude comparators: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators.

**UNIT-II:** Phase Comparators

Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type- Phase comparators.

Static over current relays: Instantaneous over-current relay-Time over-current relays basic principles –definite time and Inverse definite time over-current relays.

**UNIT-III**:

Static differential relays **:**Analysis of Static Differential Relays –Static Relay schemes –Duo bias transformer differential protection –Harmonic restraint relay.

Static distance relays: Static impedance reactance–MHO and angle impedance relay sampling comparator –realization of reactance and MHO relay using sampling comparator.

**UNIT-IV**:

Multi-Input Comparators Conic section characteristics-Three input amplitude comparator –Hybrid comparator-switched distance schemes –Poly phase distance schemes- phase fault scheme.

Power swings: Effect of power swings on the performance of distance relays –Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.

**UNIT-V**: Microprocessor Based Protective Relays

(Block diagram and flowchart approach only)-Over current relays–impedance relays-directional relay-reactance relay .Generalized mathematical expressions for distance relays-measurement of resistance and reactance –MHO and offset MHO relays-Realization of MHO characteristics Realization of offset MHO characteristics.

**TEXTBOOKS:**

1. A.G. Phadkeand J. S. Thorp, “Computer Relaying for Power Systems”,Wiley /Researchstudies

Press,2009.

2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999.

**REFERENCES:**

1. GerhardZeigler,“NumericalDistanceProtection”,SiemensPublicisCorporate Publishing,2006.

2. S.R.Bhide“DigitalPowerSystemProtection”PHILearningPvt.Ltd.2014.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**HVDC TRANSMISSION**

**(19B21AT)**

**M.Tech EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems and Power Electronics**

**Course Objectives:** Students will be able to:

1. Understand state of the art HVDC technology.

2. Learn the Methods to carry out modeling and analysis of HVDC system frontier- area power flow regulation.

**Course Outcomes**: Students will be able to:

1. To expose the students to the state of the art HVDC technology.
2. Knowledge of modeling and analysis of HVDC system for inter-area power flow regulation.
3. Able to analyze the converter and dc grid faults and methods to mitigate them.
4. Understand the HVDC converter reactive power requirements and identifying the necessary means to address those issues.

**UNIT-I:** GENERAL ASPECTS OF DC TRANSMISSION

Evolution of HVDC transmission, Comparison of HVDC and HVAC systems, Types of

DC links, Components of a HVDC system, Three-phase Converters, Pulse number, choice of best circuit for HVDC converters.

**UNIT-II:** ANALYSIS OF HVDC CONVERTER

Analysis of simple rectifier circuits, required features of rectification circuits for HVDC transmission.

Analysis of HVDC converter: Different modes of converter operation, Output voltage waveforms and DC voltage in rectification, Output voltage waveforms and DC in inverter operation, Thyristor/Valve voltages. Equivalent electrical circuit.

**UNIT-III:** DC LINK CONTROL

Grid control, basic means of control, power reversal, limitations of manual control, Constant current versus Constant Voltage, Desired features of control. Actual control characteristics: Constant-minimum-ignition-angle control, Constant- current control, Constant-extinction-angle control. Stability of control, tap-changer control,Power control and current limits, frequency control.

**UNIT-IV:** CONVERTER FAULTS & PROTECTION

Converter fault-operations, Commutation failure, Starting and shutting down the converter bridge, Converter protection.

**UNIT-V:** REACTIVE POWER MANAGEMENT & AC-DC POWER FLOW ANALYSIS

Smoothing reactor and DC Lines ,Reactive power requirements, Harmonic analysis, Filter design, Power flow Analysis in AC/DC systems – Modelling of DC links – solutions of AC-DC Power flow.

**TEXT BOOKS**:

1. J. Arrillaga, “High Voltage Direct Transmission”, Peter Peregrinus Ltd. London, 1983.

2. K. R. Padiyar, “HVDC Power Transmission Systems”, Wiley Eastern Ltd., 1990.

**REFERENCES:**

1. E. W. Kimbark, “Direct Current Transmission”, Vol. I, Wiley Interscience, 1971.

2. Erich Uhlmann, “Power Transmission by Direct Current”, B.S. Publications, 2004.

3. SN Singh, “Electric Power Generation, Transmission and Distribution, PHI, New

Delhi 2nd edition, 2008.

4. V. Kamaraju, ”HVDC Transmission” Tata McGraw-Hill Education Pvt Ltd,New delhi,2011.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**WIND AND SOLAR SYSTEMS**

**(19B21BT)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems and Electrical Machines**

**Course Objectives**

1. To get exposure to wind and solar systems
2. To understand the factors involved in installation and commissioning of a Solar or Wind plant.
3. Learning the dynamics involved when interconnected with power system grid

**Course Outcomes** Students will be able to:

1. Understand the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems.
2. Gain the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems.
3. Gain the knowledge of physics of solar power generation and the associated issues.
4. Identify, formulate and solve the problems of energy crises using wind and solar energy

**UNIT-I** Historical development and current status: Introduction – historical background – current status of wind power worldwide – status of wind turbine technology. Characteristics of wind power generation – basic integration issues: consumer requirements – requirements from wind farm operators – the integration issues.

**UNIT – II** Generators and Power Quality for wind turbines: generator concepts – power electronic concepts – power electronic solutions in wind farms. Power quality standards of wind turbines: Power Quality characteristics of wind turbines.

**UNIT- III** Isolated systems with wind power: isolated power systems – overview of wind – diesel power systems – wind power impact on power quality. Reactive power capability and voltage control: Relevance and design paradigm – Reactive power capability of a wind turbine.

**UNIT – IV** Solar energy: merits, demerits – thermal applications. Concentrating collectors - devices for thermal collection & storages – Thermal energy storage: sensible heat storage, latent heat storage, Thermo chemical storage - solar pond: principle of working – description.

**UNIT- V** Applications: Water pumping – battery chargers – solar car – direct-drive applications –solar thermal applications-heating, cooling, desalination, drying, cooking.

**Text Books**

1. Wind power in Power Systems by Thomas Ackerman, John Willy & Sons ltd.
2. Solar Energy by K. Sukhatme& S.P. Sukhatme, TMH, 2nd Edition.

**REFERENCES:**

1. “Understanding Renewable Energy Systems”, by Volker Quaschning, 2005, UK.

2. “Renewable Energy Systems-Advanced Conversion, Technologies & Applications” by Faner Lin Luo Honer Ye, CRC press, Taylor & Francis group.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**RESTRUCTURED POWER SYSTEMS**

**(19B21CT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course Objectives** Students will be able to:

1. Understand what is meant by restructuring of the electricity market.
2. Understand the need behind requirement for deregulation of the electricity market.
3. Understand the money, power & information flow in a deregulated power system.

**Course Outcomes** Students will be able to:

1. Understand various types of regulations in power systems.
2. Identify the need of regulation and deregulation.
3. Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4. Identify and give examples of existing electricity markets.
5. Classify different market mechanisms and summarize the role of various entities in the market

**UNIT I** Deregulation of Electric Utilities: Introduction – Traditional central utility model, reform motivations, separation of ownership and operation, competition and direct access in the electricity market, independent system operator (ISO), retail electric providers, different experiences.

**UNIT II** Competitive Wholesale Electricity: Markets & Transmission Open Access: Introduction, ISO, wholesale electricity market characteristics, market model, challenges, trading arrangements, the pool and bilateral trades, multi lateral trades.

**UNIT III** Transmission Cost Allocation Methods: Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

**UNIT IV** Market Power & Ancillary Services Management: Introduction - Different types of market Power – Mitigation of Market Power – Examples - Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

**UNIT V** Available Transfer Capability (ATC) : Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow - Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

**Text Books:**

1. Power System Restructuring and Deregulation, Loi Lei Lai, John Wiley & Sons Ltd., England, 2001.
2. Operation of Restructured Power System, Kankar Bhattacharya, Math H.J. Boller and Jaap E. DaalderKulwer Academic Publishers, 2001.
3. Restructured Electrical Power Systems, Mohammad Shahidehpour and Muwaffaqalomoush, Marcel Dekker, Inc., 2001.

**REFERENCES:**

1. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, “Operation of

restructured power systems”, Kluwer Academic Pub., 2001.

2. Mohammad Shahidehpour, MuwaffaqAlomoush, “Restructured electrical power systems: operation, trading and volatility”, Marcel Dekker.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**MODERN CONTROL THEORY**

**(19B21DT)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Control Systems**

1. To explain the concepts of basics and modern control system for the real time analysis and design of control systems.
2. To explain the concepts of state variables analysis.
3. To study and analyze nonlinear systems.
4. To analyze the concept of stability for nonlinear systems and their categorization.
5. To apply the comprehensive knowledge of optimal theory for Control Systems.

Course Outcomes: Upon completion of this course, students should be able to:

1. Various terms of basic and modern control system for the real time analysis and design of control systems.

1. Perform state variables analysis for any real time system.
2. Apply the concept of optimal control to any system.
3. Able to examine a system for its stability, controllability and observability.
4. Implement basic principles and techniques in designing linear control systems.
5. Formulate and solve deterministic optimal control problems in terms of performance indices.

7. Apply knowledge of control theory for practical implementations in engineering and network analysis.

**UNIT I**: Mathematical Preliminaries and State Variable Analysis:

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear systems – The concept of state – State space model of Dynamic systems – Time invariance and Linearity – Non uniqueness of state model – State diagrams for Continuous-Time State models - Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and it’s properties.

**UNIT II:** Controllability and Observability:

General concept of controllability – Controllability tests, different state transformations such as diagonalization, Jordon canonical forms and Controllability canonical forms forContinuous-Time Invariant Systems – General concept of Observability – Observability tests for Continuous-Time Invariant Systems – Observability of different State transformation forms.

**UNIT III:** State Feedback Controllers and Observers:

State feedback controller design through Pole Assignment, using Ackermann’s formula– State observers: Full order and Reduced order observers.

**UNIT IV:** Non-Linear Systems:

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone- Backlash – Jump Phenomenon etc; Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

**UNIT V:** Stability Analysis:

Stability in the sense of Lyapunov, Lyapunov’s stability and Lypanov’s instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions.

**TEXTBOOKS :**

1. M.Gopal, Modern Control System Theory, New Age International - 1984
2. Ogata. K, Modern Control Engineering, Prentice Hall - 1997

**REFERENCES**

1. N K Sinha, Control Systems, New Age International – 3rd edition.

2. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**ELECTRICAL POWER DISTRIBUTION SYSTEM**

**(19B21ET)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course Objectives**: Students will be able to

1. Learning about power distribution system
2. Learning of SCADA System
3. Understanding Distribution Automation

**Course Outcomes:** Students will be able to

1. Knowledge of power distribution system
2. Study of Distribution automation and its application in practice
3. To learn SCADA system

**UNIT-I:**

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting.

**UNIT-II:**

Advantages of Distribution Management System (D.M.S.) Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction

**UNIT-III:**

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation. SCADA: Introduction, Block Diagram, SCADA Applied To Distribution Automation. Common Functions of SCADA, Advantages of Distribution Automation through SCADA

**UNIT-IV:**

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman’s Optimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution & Monitoring

**UNIT-V:**

Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution. Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation

**TEXT BOOKS:**

1. A.S. Pabla, “ Electric Power Distribution”, Tata McGraw Hill Publishing Co.

Ltd., Fourth Edition.

1. M.K. Khedkar, G.M. Dhole, “A Text Book of Electrical power Distribution

Automation”,University Science Press, New Delhi

**REFERENCES**:

1. Anthony J Panseni, “Electrical Distribution Engineering”, CRC Press

2. James Momoh, “Electric Power Distribution, automation, protection & control”, CRC Press

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**REACTIVE POWER COMPENSATION AND MANAGEMENT**

**(19B21FT)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course Objectives**:

1. To identify the necessity of reactive power compensation
2. To describe load compensation
3. To select various types of reactive power compensation in transmission systems
4. To illustrate reactive power coordination system

5. To characterize distribution side and utility side reactive power management.

**Course Outcomes**: Upon the completion of this course, the student will be able to

1. Distinguish the importance of load compensation in symmetrical as well as un symmetrical loads

2. Observe various compensation methods in transmission lines

3. Construct model for reactive power coordination

4. Distinguish demand side reactive power management & user side reactive power management

**UNIT-I:** LOAD COMPENSATION

Objectives and specifications – reactive power characteristics – inductive and capacitive Approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

**UNIT-II**: STEADY–STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEM

Uncompensated line – types of compensation – Passive shunt, series and dynamic shunt compensation – examples.

TRANSIENT STATE REACTIVE POWER COMPENSATION IN TRANSMISSION SYSTEMS:

Characteristic time periods – passive shunt compensation – static compensations – series capacitor compensation – compensation using synchronous condensers – examples.

UNIT-III: **REACTIVE POWER COORDINATION**

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences.

UNIT-IV**: DEMAND SIDE MANAGEMENT**

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.

DISTRIBUTION SIDE REACTIVE POWER MANAGEMENT:

System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

**UNIT-V:** USER SIDE REACTIVE POWER MANAGEMENT

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and

Limitations.

**TEXT BOOKS:**

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and

sons, 1982.

2. Reactive power Management by D.M.Tagare, Tata McGraw Hill, 2004.

**REFERENCES:**

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just “Reactive Power

Compensation: A Practical Guide, April, 2012, Wiley publication

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**MATHEMATICAL METHODS FOR POWER ENGINEERING**

**(19B21GT)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Mathematics**

**Course Objectives:** Students will be able to

1. To understand the relevance of mathematical methods to solve engineering problems.

2. To understand how to apply these methods for a given engineering problem.

**Course Outcomes:** Students will be able to

1. Knowledge about vector spaces, linear transformation, eigen values and eigenvectors of linear operators
2. To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology
3. Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems
4. Understanding the concept of random variables, functions of random variable and their probability distribution Understand stochastic processes and their classification

**UNIT-I:**

Vector spaces, Linear transformations, Matrix representation of linear transformation, Eigen values and Eigen vectors of linear operator

**UNIT-II:**

Linear Programming Problems, Simplex Method, Duality, Non Linear Programming problems

**UNIT-III:**

Unconstrained Problems, Search methods, Constrained Problems

**UNIT-IV**:

Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions

**UNIT-V:**

Independent /Dependent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes

**TEXT BOOKS:**

1. Kenneth Hoffman and Ray Kunze, “Linear Algebra”, 2nd Edition, PHI, 1992

2. Erwin Kreyszig, “Introductory Functional Analysis with Applications”, John Wiley & Sons, 2004

**REFERENCES:**

1. Irwin Miller and Marylees Miller, John E. Freund’s “Mathematical Statistics”, 6th Edn, PHI, 2002

2. J. Medhi, “Stochastic Processes”, New Age International, New Delhi., 1994

3. A Papoulis, “Probability, Random Variables and Stochastic Processes”, 3rd Edition, McGraw Hill,

2002

4. John B Thomas, “An Introduction to Applied Probability and Random Processes”, John Wiley,

2000

5. Hillier F S and Liebermann G J, “Introduction to Operations Research”, 7th Edition, McGraw Hill,

2001

6. Simmons D M, “Non Linear Programming for Operations Research”, PHI, 1975

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**HYBRID ELECTRIC VEHICLES**

**(19B21HT)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems, Electrical Machines and Power Electronics**

**Course Objectives**: Students will be able to

1. To understand upcoming technology of hybrid system
2. To understand different aspects of drives application
3. Learning the electric Traction

**Course Outcomes**: Students will be able to

1. Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.

2. To learn electric drive in vehicles / traction.

**UNIT-I:**

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, Mathematical models to describe vehicle performance

**UNIT-II:**

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

**UNIT-III:**

Introduction to electric components used in hybrid and electric Vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives configuration and control of Permanent Magnet Motor drives Configuration and control of Switch Reluctance, Motor drives, drive system efficiency

**UNIT-IV:**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology, Communications, supporting subsystems

**UNIT-V:**

Introduction to energy management and their strategies used in hybrid and electric vehicle, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

**TEXT BOOKS:**

1. Sira -Ramirez, R. Silva Ortigoza, “Control Design Techniques in Power Electronics

Devices”, Springer.

1. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, “Sliding mode control of switching

Power Converters”

**REFERENCES:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid
3. Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
5. Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle
6. (BEV).

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**RESEARCH METHODOLOGY AND IPR**

**(19BE11T)**

**M.Tech. EPS, I Sem L T P C**

3 0 0 3

**COURSE OBJECTIVES:**

1. To introduce the characteristics of a good research problem
2. To choose appropriate approaches of investigation of solutions for research problem
3. To familiarize with basic Intellectual Property Rights
4. To understand different Patent Rights

**COURSE OUTCOMES:**  At the end of this course, students will be able to

1. Comprehend research problem formulation, analyze research related information and follow research ethics
2. Realize the importance of ideas, concept, and creativity in the present-day context.
3. Recognize the need of Intellectual Property Right in general & engineering in particular.
4. Appreciate IPR protection which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**UNIT-I:**

Introduction: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

**UNIT-II:**

Literature Survey: Effective literature studies approaches, analysis. Plagiarism, Research ethics.

**UNIT-III:**

Effective technical writing: How to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT-IV:**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**UNIT-V:**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR.

**TEXT BOOKS:**

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

3. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

**REFERENCES:**

1. Ranjit Kumar, 2nd Edition , “Research Methodology: A Step by Step Guide for beginners”
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov , “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008
7. C.R. Kothari and Gaurav Garg, “Research Methodology: Methods and Techniques”, New Age International Publishers

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**(AUTONOMOUS)**

**POWER SYSTEMS SIMULATION LAB-I**

**(19B211L)**

**M.Tech. EPS, I Sem L T P C**

0 0 4 2

1. Formation of Bus admittance matrix with and without off-nominal ratios of transformer of a power system network.

2. Develop Program for ZBUS.

3. Develop Program for G-S Load Flow Algorithm.

4. Develop Program for N-R Load Flow Algorithm in Polar Coordinates.

5. Develop Program for FDLF Algorithm.

6. Develop Program for DC load Flow Algorithm.

7. Develop Program for Short Circuit Analysis using ZBUS Algorithm.

8. Develop Program for Transient Stability Analysis for Single Machine connected to Infinite Bus

9. Develop Program for Economic Load Dispacth Problem using Lambda Iterative Method.

10.Develop Program for Unit Commitment Problem using Forward Dynamic Programming Method.

11.Develop Program for State Estimation of Power System.

12 Simulink Model Of Single Area Load Frequency Control With And Without Pi Controller And With Pid Controller .

13. Simulink Model For Two Area Load Frequency Control

Note: From the above list minimum 8 experiments are to be conducted using suitable software

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**(AUTONOMOUS)**

**POWER SYSTEM PROTECTION LAB**

**(19B212L)**

**M.Tech.EPS, I Sem L T P C**

0 0 4 2

Any Eight of the following experiments has to be carried out

1. Characteristics of IDMT Over Current Relay (Electromagnetic Type).

2. Characteristics of Negative Phase Sequence relay (Static Type).

3. Characteristics of Percentage biased differential Relay (static type).

4. Characteristics of Over Voltage Relay (Electromagnetic Type).

5. Characteristics of over voltage/under voltage relay (Micro processor Based Type).

6. Characteristics of Percentage Biased Differential Relay (Electromagnetic Type).

7. Equivalent Circuit of three winding transformer.

8. Scott Connection.

9. Fault Analysis – I

1. LG Fault
2. LL Fault

10. Fault Analysis – II

A. LLG Fault

B. LLLG Fault

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**(AUTONOMOUS)**

**EHVAC TRANSMISSION**

(**19B221T)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course objectives:**

1. To identify the different aspects of Extra High Voltage A.C and DC Transmission design and analysis

2. To understand the importance of modern developments of EHV and UHV transmission systems.

3. To demonstrate EHV AC transmission system components, protection and insulation level for over voltages.

**Course Outcomes:** Upon the completion of this course, the student will be able to

1. Understand the importance of EHV AC transmission

2. Estimate choice of voltage for transmission, line losses and power 2.handling capability of EHV Transmission.

3. Analyze the statistical procedures for line designs, scientific and engineering principles in power systems.

**UNIT- I:** E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission

voltages – Estimation at line and ground parameters-Bundle conductor systems- Inductance and Capacitance of E.H.V. lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

**UNIT- II**: Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines –

effect of high electrostatic field on biological organisms and human beings - surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor.

**UNIT- III:** Electrostatic induction in unenergized lines – measurement of field and voltage gradients

for three phase single and double circuit lines – unenergized lines. Power Frequency Voltage control and over-voltages in EHV lines: No load voltage – charging currents at power frequency-voltage control – shunt and series compensation – static VAR compensation.

**UNIT - IV:** Corona in E.H.V. lines – Corona loss formulae- attention of traveling waves due to

Corona – Audio noise due to Corona, its generation, characteristic and limits. Measurements of audio noise radio interference due to Corona - properties of radio noise

– frequency spectrum of RI fields – Measurements of RI and RIV.

**UNIT- V:** Design of EHV lines based on steady state and transient limits - EHV cables and their

characteristics

**TEXT BOOKS:**

1. R. D. Begamudre, “EHVAC Transmission Engineering”, New Age International (p) Ltd. 3rd Edition.

2. K.R. Padiyar, “HVDC Power Transmission Systems” New Age International (p) Ltd. 2nd revised Edition, 2012.

**REFERENCES:**

1. S. Rao “EHVAC and HVDC Transmission Engineering. Practice” Khanna publishers.

2. Arrillaga. J “High Voltage Direct Current Transmission” 2nd Edition (London) Peter Peregrines, IEE, 1998.

3. Padiyar.K.R, “FACTS Controllers in Power Transmission and Distribution” New Age International Publishers, 2007.

4. Hingorani H G and Gyugyi. L “Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems” New York, IEEE Press, 2000.

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**(AUTONOMOUS)**

**POWER SYSTEM CONTROL AND STABILIITY**

**(19B222T)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Pre-requisites: Power system operation and control, Electrical Machines**

**Corse Objective:**

1. To analyze the concept of power system stability, response to small disturbances and power system stabilizer

2. To gain the knowledge of excitation systems and voltage stability

**UNIT-I** THE ELEMENTARY MATHEMATICAL MODEL**:** Definition of Stability, Classification of power system stability, Rotor angle stability, frequency stability, voltage stability, midterm and long term stability, transient and steady state stability, Dynamics of synchronous machine, Development of swing equation, Classical model of one machine connected to an infinite bus – Equal area criteria, Classical model of multi machine system –Problems, Effect of the excitation system on Transient stability.

**UNIT-II** SYSTEM RESPONSE TO SMALL DISTURBANCES**:** The unregulated synchronous Machine – Demagnetizing effect of armature reaction –Effect of small changes of speed – modes of oscillation of an unregulated Multi machine system – regulated synchronous machine – voltage regulator with one time lag – Governor with one time lag – Problems. Concept of Dynamic stability – state space model of one machine system connected to infinite bus – effect of excitation on Dynamic stability – examination of dynamic stability by Routh’s criterion

**UNIT-III** POWER SYSTEM STABILIZERS**:** Introduction to supplementary stabilizing signals- Block diagram of the linear system- Approximate model of the complete exciter generator system – Lead compensation

**UNIT-IV** EXCITATION SYSTEMS**:** Excitation system response – Non-continuously regulated systems – continuously regulated systems – Excitation system compensation – state space description of the excitation system- simplified linear model – effect of excitation on generator power limits. Type –2 systems: rotating rectifier system, Type-3 system: Static with terminal potential and current supplies - Type –4 systems: non – continuous acting - Block diagram representation – state space modeling equations of these types.

**UNIT-V** VOLTAGE STABILITY**:** Voltage stability –voltage collapse, voltage security, physical relation indicating dependence of voltage and reactive power flow, Factors affecting voltage instability and collapse – Previous case of voltage collapse incidences, PV curve-QV curve- Control of voltage instability. Voltage Stability analysis-Static & Dynamic Analysis-The Continuation Power Flow Analysis-Prevention of voltage collapse

**TEXT BOOKS**

1. P.M.Anderson, A.A.Fouad, “Power System Control and Stability”, IOWA State University Press, Galgotia Publications, New Delhi, 2003.
2. ‘Power system stability and control” by PrabhaKundur,MCGrawhill-Inc, USA, 1994
3. D.P.Kothari and I.J.Nagrath, “Modern Power System Analysis”, third edition, TMH Publications, 2003.

**REFERENCE BOOKS**

1. M.A.Pai, Power System Stability – Analysis by the direct method of Lyapunov.North Holland Publishing Company, Newyork, 1981.

2. K.R. Padiyar, Power System Dynamics (Stability & Control), 2nd Edition B.S.Publications, 2002.

3. Edward Wilson Kimbark, “Power System stability: Synchronous Machines”, Dover publications Inc., New York.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**SMART GRID TECHNOLOGIES**

**(19B22AT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course Objectives:** Students will be able to

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

**Course Outcomes:** Students will be able to

1. Appreciate the difference between smart grid & conventional grid

2. Apply smart metering concepts to industrial and commercial installations

3. Formulate solutions in the areas of smart substations, distributed generation and wide area measurements

4. Come up with smart grid solutions using modern communication technologies

**UNIT-I**: Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid,

Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid Present development & International policies in Smart Grid

**UNIT-II:** Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter

Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation .

**UNIT-III**: Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their

application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit(PMU)

**UNIT-IV:** Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines, Captive power plants, Integration of renewable energy sources

**UNIT-V:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit. Advanced Metering Infrastructure (AMI) and Various Communication means and IP based Protocols.

**TEXT BOOKS:**

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE,

2011

2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand

Response”,CRC Press , 2009

**REFERENCES:**

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and

Applications”, Wiley 2012

2. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions “ CRC Press

3. A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**ECONOMIC OPERATION OF POWER SYSTEM**

**(19B22BT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Electrical Power Systems**

**Course Objectives:** Students will be able to:

1. Formulate and derive the necessary conditions for economical load scheduling problem.
2. Understand various constraints, problem formulation and methods to solve the unit commitment problem.
3. Understand the constraints related to hydel power plants, problem formulation and solution techniques for hydro-thermal scheduling problem.
4. Understand the necessity, factors governing the frequency control and analyze the uncontrolled and controlled LFC system.
5. Understand the basic difference between ELS and OPF problem, formulation of the OPF problem and solution techniques.

**Course Outcomes:**

1. Student can solve the economic load scheduling with and without network losses both in classical method and iterative methods.
2. Student can solve the unit commitment problem using priority-list method and forward-dynamic method.
3. Should able to solve hydro-thermal scheduling problem for short-term and long- term range.
4. Should able to analyze the single area and two area systems for frequency deviation under sudden change in load.
5. Should able to solve the OPF problem using ac and dc load flow methods.

**UNIT-I:** ECONOMIC LOAD SCHEDULING

Characteristics of Steam Turbine, Variations in steam unit characteristics, Economic dispatch with piecewise linear cost functions, Lambda Iterative method, LP method, Economic dispatch under composite generation production cost function, Base point and Participation factors, Thermal system Dispatching with Network losses considered.

**UNIT-II**: UNIT COMMITMENT

Unit Commitment – Definition – Constraints in Unit Commitment–Unit Commitment solution methods – Priority–List Methods – Dynamic Programming Solution.

**UNIT-III**: HYDRO THERMAL SCHEDULING

Characteristics of Hydroelectric units, Introduction to Hydrothermal coordination, Long- Range and Short-Range Hydro-Scheduling, Hydroelectric plant models, Hydrothermal scheduling with storage limitations, Dynamic programming solution to hydrothermal scheduling.

**UNIT-IV:** LOAD FREQUENCY CONTROL

Control of generation – models of power system elements – modeling of LFC of single area system – static and dynamic analysis – LFC of two area system – static and dynamic analysis. Automatic generation control– features– implementation

**UNIT-V:** OPTIMAL POWER FLOW IN CONCERN WITH ECNOMIC

Introduction to Optimal power flow problem, OPF calculations combining economic dispatch and power flow, OPF using DC power flow, Algorithms for solution of the

ACOPF, Optimal Reactive Power Dispatch.

**TEXT BOOKS:**

1. J.J. Grainger &W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2003

2. Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé-Power Generation, Operation and Control-Wiley-Interscience (2013)

**REFERENCES:**

1. Olle l. Elgerd, “Electric Energy Systems Theory an Introduction”, TMH, 2nd Edition,

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**(AUTONOMOUS)**

**SWARM INTELLIGENCE TECHNIQUES IN POWER SYSTEMS**

**(19B22CT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Artificial Intelligence Techniques in Electrical Engineering**

**Course Objectives:** Students will be able to:

1. Understand Evolutionary algorithms like GA, PSO, ANT COLONY and BEE COLONY etc.

2. Apply these Evolutionary algorithms to solve power systems problems

3. Also able to understand solution of Multi-Objective optimization using these algorithms

**Course Outcomes:** Upon the completion of this course, the student will be able to

1. Discriminate the capabilities of bio-inspired system and conventional methods in solving optimization problems.

2. Examine the importance of exploration and exploitation swarm intelligent system to attain near global  optimal solution.

3. Distinguish the functioning of various swarm intelligent systems.

4. Employ various bio-inspired algorithms for power systems engineering applications.

**UNIT-I:** FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES

Definition-classification of optimization problems-unconstrained and constrained

optimization optimality conditions-Introduction to intelligent systems-soft computing techniques-conventional computing versus swarm computing-classification of meta- heuristic techniques-single solution based and population based algorithms-exploitation and exploration in population based algorithms-Properties of Swarm intelligent Systems

**UNIT-II:** GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION Genetic algorithms-Genetic algorithm versus Conventional Optimization Techniques- Genetic representations and selection mechanisms: Genetic operators-different types of crossover and mutation operators-Bird flocking and Fish Schooling-anatomy of a particle-equations based on velocity and positions-PSO topologies-control parameters- GA and PSO algorithms for solving ELD problems.

**UNIT-III:** ANT COLONY OPTIMIZATION and ARTIFICIAL BEE COLONY ALGORITHMS

Biological ant colony system-Artificial ants and assumptions –Stigmergic communications-pheromone updating-local-global-pheromone evaporation-ant colony system-ACO models-Touring ant colony system-max min ant system-concept of elastic ants-Task partitioning in honey bees-Balancing foragers and receivers-Artificial bee colony (ABC) algorithms-binary ABC algorithms-ACO and ABC algorithms for solving Economic Dispatch of thermal units.

**UNIT-IV:** SHUFFLED FROG-LEAPING ALGORITHM and BAT OPTIMIZATION ALGORITHM

Bat algorithm-Echolocation of bats-Behaviour of micro bats-Acoustics of echolocation- Movement of Virtual bats-Loudness and pulse Emission-Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes-memeplex formation-memeplex updation-BA and SFLA algorithms for solving ELD and optimal placement and sizing of the DG problem.

**UNIT-V**: MULTI OBJECTIVE OPTIMIZATION

Multi-Objective optimization introduction-concept of pareto optimality-Non-dominant sorting technique-pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and applications to power systems

**TEXT BOOKS:**

1. Xin-She Yang, ‘Recent Advances in Swarm Intelligence and Evolutionary Computation’ Springer International Publishing, Switzerland, 2015.

2. Kalyanmoy Deb ‘Multi-Objective Optimization using Evolutionary Algorithms’, John Wiley & Sons,        2001.

**REFERENCES:**

1. James Kennedy and Russel E Eberheart, ‘Swarm Intelligence’, The Morgan Kaufmann Series       in Evolutionary Computation, 2001.

2. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, ‘Swarm Intelligence-From natural to Artificial      Systems’, Oxford university Press, 1999.

3. David Goldberg, ‘Genetic Algorithms in Search, Optimization and Machine Learning’, Pearson       Education, 2007.

4. Konstantinos E. Parsopoulos and Michael N. Vrahatis, ‘ Particle Swarm Optimization and       Intelligence: Advances and Applications’, Information Science reference, IGI Global, 2010.

5. N P Padhy, ‘Artificial Intelligence and Intelligent Systems’, Oxford University Press, 2005.

**REFERENCE PAPERS:**

1. “Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization” by Muzaffar eusuff, Kevin lansey and Fayzul pasha, Engineering Optimization, Taylor & Francis, Vol. 38, No. 2, pp.129-154, March 2006.

2. “A New Metaheuristic Bat-Inspired Algorithm” by Xin-She Yang, Nature Inspired Cooperative Strategies for Optimization (NISCO 2010) (Eds. J.R. Gonzalez et al.), Studies in Computational Intelligence, Springer Berlin, 284, Springer, 65-74 (2010).

3. “Firefly Algorithms for Multimodal Optimization” Xin-She Yang, O. Watanabe and T. Zeugmann (Eds.), Springer-Verlag Berlin Heidelberg, pp. 169-178, 2009.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**INDUSTRIAL LOAD MODELLING AND CONTROL**

**(19B22DT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course Objectives:** Students will be able to

1. To understand the energy demand scenario

2. To understand the modeling of load and its ease to study load demand industrially

3. To know Electricity pricing models

4. Study Reactive power management in Industries

**Course Outcomes:** Students will be able to

1. Knowledge about load control techniques in industries and its application.

2. Different types of industrial processes and optimize the process using tools like LINDO and LINGO.

3. Apply load management to reduce demand of electricity during peak time.

4. Apply different energy saving opportunities in industries.

**UNIT-I:**

Electric Energy Scenario-Demand Side Management-Industrial Load Management. Load Curves-Load Shaping Objectives-Methodologies. Barriers; Classification of Industrial Loads- Continuous and Batch processes -Load Modeling.

**UNIT-II:**

Direct load control- Interruptible load control. Bottom up approach- scheduling- Formulation of loadmodels- Optimization and control algorithms - Case studies. Reactive power management in industries-controls-power quality impacts, application of filters, Energy saving in industries.

**UNIT-III:**

Cooling and heating loads- load profiling- Modeling. Cool storage-Types- Control strategies. Optimal operation-Problem formulation- Case studies.

**UNIT-IV:**

Captive power units- Operating and control strategies- Power Pooling- Operation models. Energy banking-Industrial Cogeneration

**UNIT-V:**

Selection of Schemes Optimal Operating Strategies. Peak load saving-Constraints- Problem formulation Case study. Integrated Load management for Industries

**TEXT BOOKS**:

1. C.O. Bjork “Industrial Load Management - Theory, Practice and Simulations",Elsevier, the Netherlands,1989.

2. C.W. Gellings and S.N. Talukdar, “Load management concepts,” IEEE Press, New York, 1986,pp. 3-28.

**REFERENCES:**

1. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April     1981.

2. H. G. Stoll, "Least cost Electricity Utility Planning”, Wiley Interscience Publication, USA, 1989.

3. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw

Hill publishers, New Delhi, 1995.

4. IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective     planning in Industrial facilities”, IEEE Inc, USA.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**AI TECHNIQUES IN POWER SYSTEMS**

**(19B22ET)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Artificial Intelligence Techniques in Electrical Engineering**

**Course Objectives**: Students will be able to

1. Understanding fuzzy logic, ANN
2. Understanding GA & EP

**Course Outcomes**: Students will be able to

1. Learn the concepts of biological foundations of artificial neural networks
2. Learn Feedback networks and radial basis function networks and fuzzy logics
3. Identifications of fuzzy and neural network
4. Acquire the knowledge of GA

**UNIT-I:**

Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer

and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks.

**UNIT-II:**

Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification

Methods. Fuzzy Neural Networks and their learning methods

**UNIT-III:**

System Identification using Fuzzy and Neural Network.

**UNIT-IV:**

Genetic algorithm, Reproduction cross over, mutation, Introduction to evolutionary

program.

**UNIT-V:**

Applications of above mentioned techniques to practical problems

**TEXT BOOKS**:

1. J M Zurada , “An Introduction to ANN”,Jaico Publishing House

2. Simon Haykins, “Neural Networks”, Prentice Hall

**REFERENCES:**

1. Timothy Ross, “Fuzzy Logic with Engg.Applications”, McGraw. Hill

2. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication

3. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**POWER QUALITY**

**(19B22FT)**

**M.Tech. EPS,IISem L T P C**

3 0 0 3

**Prerequisite: Power Systems and Power Electronics**

**Course Objectives:**

1. To know different terms of power quality.
2. To illustrate power quality issues for short and long interruptions.
3. To construct study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
4. To know the behavior of power electronics loads, induction motors, synchronous motor etc. by the power quality issues
5. To know mitigation of power quality problems.

**Course Outcomes**: Upon the completion of this course, the student will be able to

1. Know the severity of power quality problems in distribution system;

2. Understand the concept of voltage sag transformation from up-stream (higher voltages)to down-stream(lower voltage)

3. Compute the power quality improvement by using various mitigating custom power devices.

**UNIT-I:** INTRODUCTION

Introduction of the Power Quality (PQ) problem: Terms used in PQ-Voltage Sag,Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

**UNIT-II:** LONG INTERRUPTIONS

long Interruptions: Definition, causes of Long Interruptions, Origin of Interruptions–Limits for the Interruption frequency, Limits for the interruption duration–costs of Interruption –Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

UNIT-III: SHORT INTERRUPTIONS

Short interruptions: definition, origin of short interruptions, basic principle, fuses saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of

short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage post fault period.

**UNIT-IV:** POWER QUALITY CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS

Influence on equipment-electronic equipments, induction motors, Synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation methods of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

**UNIT-V**: MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS

Overview of mitigation methods–from fault to trip, reducing the number of faults, reducing the fault clearing time, changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface–voltage source converter, series voltage controller, shunt voltage controller, combined shunt and series controller.

**TEXTBOOKS:**

1. MathHJ Bollen“Understanding Power Quality Problems”,IEEEPress.

2. R.C. Dugan, M.F. McGranaghan and H.W. Beaty, “Electric Power Systems Quality.”NewYork:McGraw-      Hill.1996

**REFERENCES:**

1.G.T.Heydt,‘ElectricPowerQuality’,2ndEdition.(WestLafayette,IN,StarsinaCirclePublications,1994)

2. Power Quality VAR Compensation in Power Systems, R. Sastry Vedam MulukutlaS.Sarma,CRCPress.

3. A Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power

Devices.KluwerAcademic,2002

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**POWER APPARATUS DESIGN**

**(19B22GT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Electrical Machines**

**Course Objectives**: Students will be able to

1. Study the modeling analysis of rotating machine.

2. Learning electromagnetic energy conversion

3. To know about rating of machines.

**Course Outcomes:**

1. To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used.

2. Ability to model and design all types of rotation machines including special machines.

UNIT-I:

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings,Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling.

UNIT-II:

Specific loadings, choice of magnetic and electric loadings Real and apparent flux - densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating.

UNIT-III:

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes, Calculation of losses, efficiency and regulation, Forces winding during short circuit.

UNIT-IV:

General considerations, output equation, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor, Elimination of harmonic torques.

UNIT-V:

Design of stator and rotor winding, slot leakage flux, Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data. Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions Introduction to Computer Aided Electrical Machine Design Energy efficient machines.

**TEXT BOOKS:**

1. Clayton A.E, “The Performance and Design of D.C. Machines”, Sir I. Pitman& sons, Ltd.

2. M.G. Say, “The Performance and Design of A.C. Machines “, Pitman

**REFERENCES:**

1. Sawhney A.K, “A course in Electrical Machine Design”, DhanpatRai & Sons, 5th Edition

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**DYNAMIC IN LINEAR SYSTEMS**

**(19B22HT)**

**M.Tech. EPS, II Sem L T P C**

3 0 0 3

**Prerequisite: Control Systems**

**Course Objectives**

1. To provide a strong foundation on classical and modern control theory.

2. To provide an insight into the role of controllers in a system.

3. To design compensators using classical methods.

4. To design controllers in the state space domain.

5. To impart an in depth knowledge in observer design

**Unit-1** Design of feedback control systems- Approaches to system design compensators–performance measures- cascade compensation networks phase lead and lag compensator design using both Root locus and Bode plots ,PID controllers-effect of proportional, integral and derivative gains on system performance-PID tuning-integral windup and solutions

**Unit-2** State Space Analysis and Design- Analysis of stabilization by pole cancellation- reachability and constructability - stabilizability - controllability - observability-grammians-Analysis of stabilization by output feedback-Transfer function approach - state feedback and zeros of the transfer function. Solution of Linear Time Varying System

**Unit-3** Linear state variable feedback for SISO systems, -modal controllability formulae for feedback gain -significance of controllable Canonic form Ackermann's formula feedback gains in terms of Eigen values - MayneMurdoch formula - non controllable realizations and stabilizability - controllable and uncontrollable modes - regulator problems

**Unit-**4 Observers: Asymptotic observers for state measurement-open loop observer-closed loop observer-formulae for observer gain -implementation of the observer - full order and reduced order observers - separation principle - combined observer -controller – optimality criterion for choosing observer poles

**Unit-**5 Direct transfer function design procedures – Design using polynomial equations - Direct analysis of the Diophantine equation. MIMO systems: Introduction, controllability, observability, different companion forms for MIMO systems

**Text books**

1. Seborg . Process dynamic control, Wiley, 2007

2. Ernest O. Doebelin . Measurement system Application and Design. McGraw Hill International Editions, 1990

3. N. Viswanathan, Y. Narahari . Performance modeling of automated manufacturing system, Prentice Hall of India Private Limited, New Delhi, 2001 4.

4, Proceedings: Conference on Advances in computing, CADCOM 98, Allied Publishers Limited, New Delhi, India, 1999

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**ACADEMIC AND RESEARCH PAPER WRITING**

**(19BC21T)**

**M.Tech EPS, II Sem L T P**

**3 0 0**

**Course objectives:**

Students will be able to:

* + - 1. Understand that how to improve your writing skills and level of readability
      2. Learn about what to write in each section
      3. Understand the skills needed when writing a Title
      4. Ensure the good quality of paper at very first-time submission

# UNIT I: Introduction

# [Introduction to Academic & Research Report writing](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5qI9SM%252bE3ghjwCdkmjHs1w2u9Hdq7cElW9cDiWOZNT7dX3DixQJqGp%252fimcp%252bkDppSlXQZ5%252bgQM4FQwJHDpGclbBSV6YECQxbJNXbxOe1fwVoUgKJpew9Do0BhUDTvDLbHH0tCRHEQqZ4%253d)

# [The language of Academic & Research Reports](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5euWgdB9p3s7pXHoK0Hb2gV7OkuSfvwPRAmBj%252fOkOP%252bixm9Qi5SAHhJoXZB0TjmpZ47HUGgfMrIsG%252bp%252bzAh%252frKugsYt3jvFh8WQGO9xJFkGUfqyJUsWjairiEKVCMLvWBsaF5rRIhTVM%253d)

# [Thesis and Research Paper writing – A brief](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5Sg2JC%252bPUZQH8J3q6V7%252bHJQAXIYix0lYnc0z83vyowpr2Lx%252b6ezdakUpTB5XxbJKLr%252bP06u%252fshiXS8duUbMOZ9y2S4VF0biXxbBagyna61kOBD3Z9OvJIsu%252fnEcaDZcQMgIUPc90P0uw%253d)

# UNIT II: Tools and Techniques

# [Introduction to Computer Aided Text Processing](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5xJUM%252feOl7mZmvw06xDaWrFhSYkMDP1HWB5O40bkNpW%252bK%252bViqwSIlBkXyC5b%252b%252b6K7NAcsw93CXC8oA3k0flgjQuitePworeh1RzfiI2dYIGEHPpz6kljjNeecRuPb0ayv95X16elBj7Q%253d)

# [Basic Document Preparation with Latex- Part 1](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5tNuamwiJuoneRL46NyXJ1YDKBE9TABWH4oKHu5pAMrItuwM9fh9QAMKzF2afH2tiNqyw0PTAxFNUoHLYU85dMXfGJqPisZvCCWX0aHk4gj9Ry6O6oWGcy2O8BTqSbdJEm03aNsyCs00%253d)

# [Basic Document Preparation with Latex- Part 2](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG58i82B1vI53S69r1bb0pcpf%252fg1sAXXrUk5cCnpIURFo%252fFaicqhKKWXAJNydDO3mcXNZiKGjoSjRZGtmo2W6x4Ljn3xTzTeTYMGXHFdfRfMaSRvi4oUCGEbJC9aiJPmJz9%252brn3HbQPPvY%253d)

# [Writing Mathematical Equation with Latex](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG56yA%252fqS4bYR%252fdJMY3LvMpz5D%252bmS12OI1MMnq%252fuS6e7I1bOCz0ntAvhy3yWl7nqCzwzOF%252f1i0Rl1B%252fgLqJ8nEaHAFY74g19VQxMwbnqcJTWprNofSPux1Hhpqvxg6sPGPR7MxqUKtv7dM%253d)

# [Writing Symbolic Expression with Latex](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5NxFTd6HWqxPwKuTnnus%252bKlNiMt4l3XMk%252fSs%252fTpElCMyoXvVlUKd1e46qGG2lyIMJ3YOSb39lLLIGD9UkQNJlT83D7MbaWg0vl43cTR%252b6aeDGfmt7urL2ZKHkSbdCB71rijoVWMTg2Pc%253d)

# [Preparing Tables in a Document with Latex](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5gLSU8VN2kzsdmVUZ4wsglZy7bNvpoQk4GVE9A9hRq%252bSh3%252f9pVW%252b0HtIyML2SPcI9gpyLTlhG1roFOZUYt38hysbFeGZn7wc3FHEUXTpsjZSAz433LgJU7SyCvd0NGuoUsnYL1a65Itw%253d)

# [Inserting Figures in a Document with Latex](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5MJhVMmhSeoOlR67S2QtwH0I6y%252fFdK%252fFF90isdkrVTanO75yzN5kkW%252fKLKQoBWgOPcqEleElRLQO1h8VSoaM0T0k%252bfPzqzShOMRxes3G%252f0SNmzulvchnipr4Evgyyu%252fD2e%252bCEYiqtxKs%253d)

# UNIT III: Thesis Writing-I

# Layout of the Thesis

# [Contents Prior to the Chapters](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5rpX2d0oUtoSs10eAjghtBmAqb1gtYj76O%252bY52swby9dMGkumSj9R9R%252f6H2rCwmYCadh8Bu7a1%252fFHmAeH678T3yAT5IqrIR2fRX3t%252bjUcGvnxyLc%252fsIqHBPz5IZTZEVdqOyXSqheZn2s%253d)

# [Preparation of Abstract](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG504f9WHZFlj0umXFHqlsxqp2LFM9JLv9SWXym49uRqzNjCMHAmWAkxwAwdJZOFzfTjJ%252bI9Y5uwq7pAXgRWAvkyVM65zgfypPTrEHs%252bzvTRQbTShPte2hVgS1U0SfCmIcotBI%252b6QRbayM%253d)

# [Introduction section for a Thesis](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5vqUmJiQ7OsTSn7hhojQAn8pN3W6lb5EyjEt7aoMSUEe3sYtHkh%252b9Cw0ofekzlZLMupPCHqH0Y52bKbghk%252bo6DauhllScB%252bi%252f%252fYv%252ba%252fmyptj0HGIGkPgSFD%252blkW7k3gNv1gkY2WveY0A%253d)

# [Literature review for a Thesis](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5o%252fFzqQJ5dk7Ou6gvO82DfkB0QNuIUhtBX4qJGM09n2UgsNORCt3z%252blCMh9N0rpPMYcA%252fGKgtyvlBbhzeM8sIshsibXOXCDoswMsjvJhWF7y2ot7PF26K28xdd5J%252fex56l8EhCLOGtkQ%253d)

# UNIT IV: Thesis Writing-II

# [Computational methodology/Experimental details](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5NQnPHfezWDr0j0lq0HiZKHsJvJ7z5P7WAkLQozvss7aQXHBGyqe4aoC%252fYuEk2AIYPVSb0KWEDYeUyHGhpAvuZssrNsgqhUWExJ3Rh8t3r8f0LJJPpediEJ1SbQjPC3UYY3lswpqC0iU%253d)

# [Preliminary studies for a Thesis](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5%252bjN8kAMrp5iJWJE4C%252fvah5DTWdnrUjMbxkoUGe%252f2GPzmLQiZWzvMWFZOlukR5aCw%252fx19PfRdosFCWLz1yyIjWsLmkAUHrnHpB2d4EsKpDrv1djeUXZYJQr9ErCaiItcHs7C9NUm9lh8%253d)

# [How to write Results and Discussion for a Thesis part – I](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5DCQjfVDuF9M18JLNvEboT1rQoIdEGCDd3m5QISgbyy%252bMm9fWudnGDSmNdgkx85j%252fmTV9C%252bvtO92vU9YUpX6ZG3s5n76hnlPZcp8hWYar1D52mNJvCsXopulCjSu8oPUOrRD5Ik%252fIhfQ%253d)

# [Data Analysis (How to write Results and Discussion for a Thesis part –](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5odY80OzPstHscCd%252fi5TLau1J6Y%252fW%252fLgKjcsPLJZou%252f9CcUXPNxFld7U74Lw%252fZ2eK5chYAtMD3pIz3R0qKhoX9fQzyuSaBd8kN9yXnQU5H0bh%252bxDmdIRsLBs4lFEx3NiNuFCmXohmRSQ%253d)I

# [Writing Conclusions, References and other information for a thesis](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5%252buiukHYHO0q1s%252bRvOUKFxCLQJLPC3V4hiQan35dq1UyplpSr5pALzM73NAYOcNlBJku5xVZvTfQJIg5YLqJModm3D7sBLfrgc6l%252b%252bto8wgWZ1AnsVJXeQbU1zkKMiJvGbWleTNtjKe4%253d)

# UNIT V: Research Paper Writing

# Writing a Research Paper

# [The Structure of a Research paper](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG51HSbS2dcVRDrs6u1kbcy%252b1yalw%252f0U0VCuPysJnCb26dE2mspvnppqo67gwIA2cM2RhgpDAanhinPo%252fwIji9xBYXYcNVyXo7CXT16lI41F4mxlTNQRz%252ft%252fGMuoaboSzMaqHQjMSeKpQ0%253d)

# [Abstract for a Paper](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5j%252b19P07nOWSK8WqotFl%252bAfQM7jbIH%252fmXJn%252bQBVhUi%252bCHnobqU5FuUXehpo6PgWFvduth51I4zz2jkLyYIntsehhO%252fvJBtuNuzOIhJe4TEGQnOyjhWCsKG72FnF4Ivcc%252b4LgnLKT7KPg%253d)

# [Introduction and Methodology sections for a Paper](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5sGI%252bnbPuEmj36aEJnCtQ1XqPOsZOpQFZ0JEe%252fLl1PYIk0S6lwDS0HY%252bMS8v0hEgzK4IGj9c5np0MGcuTo9H%252fS7%252b%252fLRJv9NUlumacuUn8y1aimOI%252bUq8xaiDvTmIN8NFGzQNh7ORS8W8%253d)

# [How to Incorporate Figure, Tables, Equations in a Research Paper](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5Qu567YcXByY9wZXg%252bt0oiZ83HZt2aUcXLR3DF9a6%252baOJw21q2jf7JEjQ7sz4YDaM9sGABomM4NKe6%252b%252f3W%252b6f8N8BQkeeB6wt7xwBcwPZ1liqG%252fY6Gjbbrqol7hciNBUxRFBSRFyR0Wc%253d)

* [How to write Results and Discussion, Conclusion sections for a Paper](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5r4KPmJCE1dqyNlbIKeUOuNAFqrHaSscizAtSpyhVhy4O1eeEbNkN3m1r%252bU8Hrt4pRG6rEZLzYUOEfM0P58yI%252fUvWN4zG1BrXRGeK3gur9cjHxiQOMZY%252fmm%252bWMCnBZsBoRO9Io2SaBao%253d)

# [Different formats for referencing](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5hdTh%252beXPHGF0zgGFJ1MsbXeVeITQW1zG4R2lNdRub9fwR3ZzCH7iFCCOLvtAaMY60mb3XrjP3zHqSMFXmufzDg0wajWeSNs7KP93qiz7zbVB1DX4HWJGvNlJ7A25IqpcopGt728xwGI%253d)

# [Ways of communicating a Research Paper](https://archive.swayam.gov.in/courses/4635-academic-and-research-report-writing/viewcourseware?cinfo=MP7Z4Xew36%252f8nWH132QnldukVy9SrdG5UFZWvKJRCnC7oZLiX7nYpth2QSjWN1btFZHeQ3fQYOtgj2ahH%252f50P%252fxKSFsvzktEWaRrkJdNrvUYu%252fv3q1N%252fjKKF98iS3U%252fzjQt3AVBmzyxORhyqw32k3PLC3o3%252bcJvwQbBpzAvXTS0%253d)

# UNIT VI: Academic and Research Report Presentation

# UNIT VII: Mini Project on Thesis Writing (with presentation)

# UNIT VIII: Mini project on Research Paper writing (with presentation)

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**(AUTONOMOUS)**

**POWER SYSTEMS LAB II**

**(19B221L)**

**M.Tech. EPS, II Sem L T P C**

0 0 4 2

**Prerequisite: Power systems and FACTS**

Any Eight of the following experiments has to be carried out

1.Determination of Line Parameters R,L andC.

2.Determination of T/ L efficiency and Regulation for a given load.

3.Analysis of Ferranti effect on Transmission Lines under light loadings.

4.Determination of ABCD parameters of a given Transmission Line Network.

5.Fault Analysis:

I. Single Line to Ground fault(L-G).

II. Line to Line fault(L-L).

III. Double Line to Ground fault (L-L-G

IV. Triple Line to Ground fault (L-L-L-G).

6.Analysis of Uncompensated lines and their voltage profiles.

7.Shunt compensation of Transmission lines (Capacitor/Reactors)

8.Load Compensation analysis

9.Line Compensation using FACTS devices.

10. Analysis of Transmission lines under Surge Impedance Loading.

11. Determination of Sequence impedance of Transmission Line and SIL analysis.

12. Develop Program for Generation System Reliability Analysis.

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**ADVANCED POWER SYSTEMS LAB**

**(19B222L)**

**M.Tech. EPS, II Sem L T P C**

0 0 4 2

Any Eight of the following experiments has to be carried out

1. Power Angle Characteristics of Salient pole Synchronous machine.

2. Determination of Sub transient Reactance of Salient pole Synchronous Machine.

3. Separation of No-Load Losses of Three Phase Squirrel cage Induction motor.

4. Determination of Sequence Impedances of Three Phase Transformer

5. Study of rooftop Solar Plant

6. Study of Wind turbine plant

7. Study of Indoor Substation

8. Study of Outdoor Substation

9. Study of Bio-mass generation plant.

10. Microprocessor based Power factor controller.

11. Microprocessor based Static VAR compensator (SVC)

12. Performance evaluation of concentrating solar collector

13. Study the A,B,C,D Parameters of an artificial transmission line(1Ph)

14. Grid Synchronization of solar PV Inverter

15. Location of Fault using Cable Fault Locator

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**(AUTONOMOUS)**

**POWER SYSTEM TRANSIENTS**

**(19B23AT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Prerequisite: Power Systems**

**Course Objectives**: Students will be able to:

1. Learn the reasons for occurrence of transients in a power system.

2. Understand the change in parameters like voltage & frequency during transients.

3. To know about the lightning phenomenon and its effect on power system.

Course Outcomes: Students will be able to:

1 .Knowledge of various transients that could occur in power system and their mathematical formulation.

2. Ability to design various protective devices in power system for protecting equipment and Personnel.

3. Coordinating the insulation of various equipments in power system.

4. Modelling the power system for transient analysis.

**UNIT-I**:

Fundamental circuit analysis of electrical transients,Laplace Transform method of solving simple Switching transients, Damping circuits -Abnormal switching transients, Three- phase circuits and transients,Computation of power system transients

**UNIT-II:**

Principle of digital computation – Matrix method of solution,Modal analysis- Z transform- Computation using EMTP,Lightning, switching and temporary over voltages, Lightning,Physical phenomena of lightning.

**UNIT-III:**

Interaction between lightning and power system,Influence of tower footing resistance and Earth Resistance, Switching: Short line or kilometric fault, Energizing transients - closing and re-closing of lines, line dropping, load rejection – over voltages induced by faults

**UNIT-IV:**

Switching HVDC line, Travelling waves on transmission line, Circuits with distributed Parameters, Wave Equation, Reflection, Refraction, Behaviour of Travelling waves at the lineTerminations, Lattice Diagrams, Attenuation and Distortion factors, Multi-conductor system and Velocity wave.

**UNIT-V:**

Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Coordination between insulation and protection level, Statistical approach. Protective devices, Protection of system against over voltages, lightning arresters, substation earthling

**TEXT BOOKS**:

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc.

New York, 1991

2. Harold A Peterson: Transient in Power Systems, McGraw Hill, 1966.

**REFERENCES:**

**1.** Kuffel and Abdullah: High Voltage Engineering, PHI, 2000.

2 Rakesh D. Begamudre: EHV AC Transmission Engineering, PHI, 2006

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**(AUTONOMOUS)**

**FLEXIBLE AC TRANSMISSION SYSTEMS**

**(19B23BT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Prerequisite: Power Electronics and Power Systems**

**Course Objectives**:

1.To understand uncompensated lines and their behavior under heavy loading conditions.

2. To understand the concept and importance controllable parameters of FACTS controllers.

3, To analyze the functioning of series controllers like GCSC, TSSC and TCSC

4. To emphasize the objectives of Shunt compensation, and basic operation of SVC

and STATCOM.

**Course Outcomes:** Upon the completion of this course, the student will be able to

1. Choose proper controller for the specific application based on system requirements

2. Understand various systems thoroughly and their requirements

3. Detect the Power and control circuits of Series Controllers GCSC, TSSC and

TCSC

4. Interpret the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability Enhancement, voltage instability prevention and power oscillation damping

**UNIT-I:** FACTS CONCEPTS

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

**UNIT-II:** VOLTAGE SOURCE CONVERTERS

Single phase & three phase full wave bridge converters, transformer connections for 12 pulse 24 and 48 pulse operation. Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

**UNIT-III**: STATIC SHUNT COMPENSATION

Objectives of shunt compensation, mid-point voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable VAR generation, variable impedance type static VAR generators switching converter type VAR generators, hybrid VAR generators.

**UNIT-IV:** STATIC SERIES COMPENSATORS

Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, and functional requirements of GTO thyristor controlled series capacitor (GSC), thyristor switched series capacitor (TSSC), and thyristor controlled series capacitor (TCSC) Control schemes for GSC, TSSC and TCSC.

**UNIT-IV:** SVC AND STATCOM

The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

**TEXT BOOKS**:

1. Hingorani H G and Gyugyi. L “ Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems” New York, IEEE Press, 2000.

2. Padiyar.K.R, “ FACTS Controllers in Power Transmission and Distribution” New

Age Int. Publishers, 2007

**REFERENCES:**

1. Zhang, Xiao-Ping, Rehtanz, Christian, Pal, Bikash “Flexible AC Transmission Systems: Modeling and Control”, Springer, 2012

2. Yong-Hua Song, Allan Johns, “Flexible AC Transmission Systems”, IET, 1

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**(AUTONOMOUS)**

**GAS INSULATED SYSTEMS**

**(19B23CT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Prerequisite: Switch Gear and Protection**

**Course objectives**:

1. To know the GIS concepts and principles
2. To distinguish Air Insulated and Gas insulated Substations
3. To demonstrate the design and constructional aspects of GIS
4. To analyze transient phenomenon, problems and diagnostic methods in GIS

**Course Outcomes**: Upon the completion of this course, the student will be able to

1. Know the advantages of GIS systems over air insulated systems

2. Observe constructional design features of GIS design

3. Discriminate the problems and design diagnostic methods of GIS

**UNIT–I:** INTRODUCTION TO GIS AND PROPERTIES OF SF6

Characteristics of GIS- Introduction to SF6 - Physical properties-Chemical properties -Electrical properties-Specification of SF6 gas for GIS application - Handling of SF6 gas before use - Safe handling of Sf6 gas in electrical equipment - Equipment for handling the SF6 Gas - SF6 and environment.

**UNIT–II:** LAYOUT OF GIS STATIONS

Advancement of GIS station - Comparison with Air Insulated Substation - Economics of GIS - User Requirements for GIS - Main Features for GIS - Planning and Installation components of a GIS station.

**UNIT–III:** DESIGN AND CONSTRUCTION OF GIS STATION

Introduction - Rating of GIS components - Design Features - Estimation of different types of Electrical Stresses -Design Aspects of GIS components - Insulation Design for Components - Insulation Design for GIS - Thermal Considerations in the Design of GIS - Effect of very Fast Transient Over-voltages (VFTO) on the GIS design - Insulation Coordination systems - Gas handling and Monitoring System Design.

**UNIT-IV:** FAST TRANSIENT PHENOMENA IN GIS

Introduction - Disconnector Switching in Relation to Very fast Transients-Origin of VFTO-Propagation and Mechanism of VFTO-VFTO Characteristics- Effects of VFTO- Testing of GIS for VFTO.

**UNIT–V:** SPECIAL PROBLEMS IN GIS AND GIS DIAGNOSTICS

Introduction - particles their effects and their control- Insulating Spacers and their Reliability - SF6 Gas Decomposition - Characteristics of imperfections in insulation - Insulation Diagnostic methods - PD Measurement and UHF Method.

**TEXT BOOKS:**

1. M. S. Naidu,” Gas Insulated Substations”- IK International Publishing House.

2. Hermann J. Koch, “Gas Insulated Substations”, June 2014, Wiley - IEEE Press.

**REFERENCES:**

1. Olivier Gallot-Lavellee, “Dielectric materials and Electrostatics” , Wiley - IEEE Press.

2. Jaun Martinez, “Dielectric Materials for Electrical Engineering”, Wiley - IEEE Press.

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**(AUTONOMOUS)**

**ENERGY STORAGE TECHNOLOGIES**

**(19B23DT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Prerequisite: None**

**Course objectives:**

1. To Understand non electrical storage technologies available

2. To Understand Electro chemical secondary batteries characteristics

3. To Appreciate various applications of storage systems

**Course outcomes**: At the end of course, students would be able to:

1. Learn Mechanical, Magnetic and Electrostatic storage systems

2. Enumerate merits and demerits of various secondary batteries

3. Study characteristics of Lead acid batteries

4.: Apply knowledge on storage technologies in EV and Power systems

**UNIT-I:** Non-electrical Storage Systems:

Flywheel, Energy Relations, Flywheel System Components, Benefits of Flywheel over Battery, Superconducting Magnet Energy Storage, Compressed Air Energy storage, Overview Thermal Energy Storage. Capacitor bank storage, Comparison of storage Technologies.

**UNIT-II:** Electro Chemical Storage:

History, General battery concepts- Types of Batteries- Primary, secondary- Battery Vs Cell, Nickel-Cadmium -Nickel-Metal Hydride, Nickel hydrogen, Lithium Ion- Lithium-Polymer, Fuel cells.

**UNIT –III:** Specifications and Characteristics:

Domains of applications of Energy storage- Starter Traction-stationary-mobile or nomadic, Review of storage requirements, Definitions of characteristics, Terminology of States, Battery Design, Battery Charging, Charge Regulators, Battery Management, General Equivalent Electrical Circuit, Performance Characteristics

**UNIT-IV:** Sealed-Lead Cells and Batteries:

Discharge Characteristics, Charging-Importance characteristics-charge acceptance-over charging, Types of charging- Constant voltage charging- Constant current charging- Taper charging-special charging- Charging power sources, storage, Testing, safety..

**UNIT–V:** Storage Applications: Electric Vehicle application- Regenerative Brake- PV module assistance-Storage bank reconfiguration- Overall cost analysis, Energy storage in Transient regimes of Power system-Problem formulation-modeling- steady tate stability analysis with storage-storage Parameters to ensure transient stability, Battery rating calculations for standalone system.

**TEXT BOOKS:**

1. Energy Storage for Power Systems, A. Ter-Gazarian, Peter Peregrinus Ltd., 1994

2. Design and Management of Energy-Efficient Hybrid Electrical Energy Storage Systems, Younghyun Kim, Naehyuck Chang, Springer, 2014

3. Rechargeable Batteries Applications Handbook, EDN Series for Design Engineers, Elsevier

**REFERENCES:**

1. Lithium Batteries and Other Electrochemical Storage Systems, Christian Glaize, Sylvie Geniès

2. Wind and Solar Power Systems, Second Edition, Mukund R.

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**(AN AUTONOMOUS INSTITUTION)**

**BUSINESS ANALYTICS**

**(19B53BT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Prerequisite: None**

**Course objectives:**

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships

between the underlying business processes of an organization.

**Course outcomes:**

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making.

**Unit1:**

**Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.

**Unit 2:**

**Trendiness and Regression Analysis**: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**Unit 3:**

**Organization Structures of Business analytics**, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

**Unit 4:**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**Unit 5:**

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

**Reference:**

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G.     Schniederjans, Christopher M. Starkey, Pearson FT Press.

2. Business Analytics by James Evans, persons Education.

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**( AUTONOMOUS)**

**OPERATIONS RESEARCH**

**(19B53DT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Prerequisite: None**

**Course Objectives:**

1. To enable the students to the nature and scope of various decision making situations within business contexts, understand and apply operations research techniques to industrial applications.
2. To learn the fundamental techniques of Operations Research and to choose a suitable OR technique to solve problem.

**Course Outcomes** : Student will be able to:

1. Create mathematical models of the real life situations and capable of obtaining best solution using Graphical Method and Simplex Method, Big M method and the student must be able to implement the theory of duality for simplifying the solution procedure for certain LPPs.
2. Solve the special cases of LPP such as Transportation, Assignment and Travelling salesmen problems.

3. Find optimal replacement period of a machine or group of parts.

**UNIT – I INTRODUCTION:**

Development – Definition– Characteristics and Phases – Types of operation and Research models– applications.

**LINEAR PROGRAMMING**: Problem Formulation – Graphical solution – Simplex method –Artificial variables techniques -Two–phase method, Big-M method – Duality Principle.

**UNIT – II TRANSPORTATION PROBLEM:**

Formulation – Optimal solution, unbalanced transportation problem –Degeneracy.

**ASSIGNMENT PROBLEM**: Formulation – Optimal solution - Variants of Assignment Problem-Travelling Salesman problem.

**UNIT – III**

**REPLACEMENT MODELS:** Introduction – Replacement of items that deteriorate with time – with change in money value - without change in money value – Replacement of items that fail completely, group replacement.

**THEORY OF GAMES:** Introduction – minimax - maximin – Criterion and optimal strategy – Solution of games with saddle points – Rectangular games without saddle points – 2 X 2 games – m X 2, 2 X n & m x n games –Graphical method, Dominance principle.

**UNIT – IV**

**WAITING LINES:** Introduction – single channel – Poisson arrivals – exponential service times – with infinite queue length models.

**SIMULATION:** Definition – Types of simulation models – phases of simulation– applications of simulation – Queuing problems – advantages and disadvantages – Simulation languages.

**UNIT – V**

**INVENTORY:** Introduction – Single item – Deterministic models – Purchase inventory models with one price break and multiple price breaks.

**DYNAMIC PROGRAMMING:** Introduction – Bellman’s Principle of optimality – Applications of dynamic programming- shortest path problem – linear programming problem.

**Text Books:**

1. S.D. Sharma, Operations Research, Kedarnath and Ramnath Publications

2. Taha, Introduction to Operations Research. PHI

3. Hiller & Libermann, Introduction to Operations Research. TMH.

**References:**

1. A.M. Natarajan, P.Balasubramani, A. Tamilarasi, Operations Research. Pearson Edu.

2. Maurice Saseini, ArhurYaspan& Lawrence Friedman, Operations Research: Methods & Problems.

3. R. Panneerselvam, Operations Research. PHI Publ.

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**INDUSTRIAL SAFETY**

**(19B13ET)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Course Objectives:**

1. To enable the students to the nature and scope of industrial safety techniques.
2. Definition and aim of maintenance engineering
3. To learn the Fault tracing and Periodic and preventive maintenance

**Course Outcomes:** Student will be able to:

1. Identify hazard and potential hazard areas.
2. Develop safety programs to prevent or mitigate damage or losses.
3. Assess safety practices and programs.
4. Conduct safety audits.
5. Improve safety practices.

**Unit-I:** Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment and methods.

**Unit-II: Fundamentals of maintenance engineering:** Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**Unit-III: Wear and Corrosion and their prevention:** Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**Unit-IV: Fault tracing**: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

**Unit-V: Periodic and preventive maintenance**: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

**Reference:**

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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**(AUTONOMOUS)**

**Cost Management of Engineering Projects**

**(19BE3AT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Course Objectives:**

1. To Prepare engineering students to analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on economic basics.

**Course Outcomes:**

1. To Be able to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives.
2. To be able to perform and evaluate payback period and capitalized cost on one or more economic alternatives.
3. To be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.

**Unit-I:**

Introduction and Overview of the Strategic Cost Management Process

**Unit-II:**

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

**Unit-III:**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

**Unit-IV:**

Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**Unit-V:**

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**References:**

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

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**(AUTONOMOUS)**

**COMPOSITE MATERIALS**

**(19B33ET)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Course Objectives:**

1. Ability to solve mechanics of composite materials problems using classical methods Assignments: Weekly problem sets are assigned.
2. Ability to do research and present on an advanced material topic Assignment: Students submit a research paper and present it in class.

**Course outcomes:**

1. Some understanding of types, manufacturing processes, and applications of composite materials
2. Ability to analyze problems on micromechanical behavior of lamina
3. Ability to analyze problems on micromechanical behavior of lamina
4. Ability to analyze problems on macro mechanical behavior of laminate

**UNIT–I**: INTRODUCTION**:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**UNIT – II**: REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

**UNIT – III:** Manufacturing of Metal Matrix Composites**:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT–IV:** Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

**UNIT – V:** Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hydro thermal failure. Laminate first play failure-insight Strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**TEXT BOOKS:**

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.

2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

**References:**

1. Hand Book of Composite Materials-ed-Lubin.

2. Composite Materials – K.K.Chawla.

3. Composite Materials Science and Applications – Deborah D.L. Chung.

4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

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**( AUTONOMOUS )**

**WIRELESS COMMUNICATIONS**

**(19B43DT)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Course objectives:**

1. To study about concepts of wireless communication systems and their applications.
2. To gain the knowledge on mobile radio propagation techniques and detailed understanding in wireless mobile communication
3. To study about different multiple access techniques and wireless channels.

**Course outcomes:**

Upon completion of the course the students able to

1. Understand concepts of wireless communication systems and their applications.
2. Know about the mobile radio propagation techniques and detailed understanding in wireless

Mobile communication.

1. Understand concepts of different multiple access techniques and wireless channels.
2. Understand the different protocols used for wireless communication systems

**UNIT I** Introduction to wireless communications systems and standards :

Evolution of mobile radio communications, Examples of Wireless Communication systems, Comparison, Second Generation Cellular Networks, Third Generation Cellular Networks , Wireless Local Loop(WLL), Bluetooth and Personal Area Networks.

**UNIT** II MOBILE RADIO PROPAGATION**:**

Large-Scale Path Loss:Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating power to electric field, the three basic Propagation Mechanisms, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering.

Small-Scale Fading and Multipath: Small scale multipath propagation, Impulse Response Model of a Multipath Channel, Small-Scale Multipath Measurements.

**UNIT III Diversity AND Spread spectrum MODULATION TECHNIQUES:**

Derivation of selection diversity and maximal ratio combining improvement, Polarization diversity, Frequency diversity, Time diversity, RAKE Receiver, Pseudo-Noise (PN) sequences, Direct sequence spread spectrum (DS-SS), Frequency Hopped spread spectrum (FH-SS), Performance of Direct sequence spread spectrum and Frequency Hopped spread spectrum.

**UNIT IV** MULTIPLE ACCESS TECHNIQUES:

Introduction, Frequency division multiple access, Time division multiple access, Spread spectrum multiple access, Space division multiple access, Capacity of cellular systems: capacity of cellular CDMA, capacity of CDMA with multiple cells, capacity of space division multiple access

**UNIT** V CAPACITY OF WIRELESS ChannelS AND MULTIPLE ANTENNAS**:**

Capacity in AWGN, Capacity of flat fading channels, Capacity of frequency selective fading channels Multiple Input Multiple output (MIMO) systems- Narrow band MIMO model, Parallel Decomposition of the MIMO Channel, MIMO channel capacity: Static channels, fading channels.

**Text Books:**

1. Theodore.S. Rappaport, “Wireless Communication, principles & practice”, 2nd Edition, Pearson

2. Andrea Goldsmith, “Wireless Communications”, Cambridge University press-2005

**ReferenceS:**

1. Kamilo Feher, ‘Wireless digital communication’, PHI, 1995.

2. John G.Proakis.“Digital Communication”,4th edition

3. A.J.Viterbi, “CDMA- Principles of Spread Spectrum”, Addison Wesley, 1995.

**ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES:: RAJAMPET**

**( AUTONOMOUS )**

**ENERGY CONVERSION SYSTEMS**

**(19B23ET)**

**M.Tech. EPS, III Sem L T P C**

3 0 0 3

**Course Objectives:**

1. Understand the sources of energy and their contributions to the energy and power needs of the nation and the world.
2. Understand the differences between large quantities of fuel and waste vs. minuscule quantities of each, but with high potential for causing harm or inconvenience

**Course Outcomes:**

1. Know percentages and have understanding for magnitudes of energy and resources used.
2. Problems assigned from text, with emphasis on the environmental effects
3. Special problems assigned regarding current events in the energy field

**Unit-I:** Introduction to Energy from Waste**:** Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters

**Unit-II**: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**Unit-III**: Biomass Gasification**:** Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**Unit-IV:** Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**Unit-V:** Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India

**References:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &

Sons, 1996