J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY

(UGC AUTONOMOUS)

Bhaskar Nagar, Moinabad Mandal, R.R. District, Hyderabad -500075

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE STRUCTURE FOR M. Tech - ELECTRICAL POWER SYSTEMS (EPS): R-22

M.TECH REGULAR TWO-YEAR DEGREE PROGRAMME

FOR THE BATCHES ADMITTED FROM THE ACADEMIC YEAR

2022 -2023

DEPARTMENT - VISION AND MISSION

VISION:

To be a Center for State-of-the Art Learning and Research in the Area of Electrical and Electronics Engineering, where the Stakeholders could Explore, Experiment and Exhibit their Expertise with an Industrial Outlook.

MISSION:

M1: To **equip** the student with advanced learning skills in the field of Electrical and Electronics Engineering as well as the professional skills necessary to face the challenges of the future.

M2: To **engineer** the student to engage in research activities leading to innovative applications of technology for the benefit of society.

M3: To **enable** the student with the qualities of leadership and social responsibility.

M. Tech. - Electrical Power Systems

Program Educational Objectives (PEOs):

1. Graduates of electrical power systems, who are employable in public and private industries /institutes /organizations or pursue higher education.
2. Ability to identify and address current and future problems in the domain of power system.
3. Inculcate research attitude and lifelong learning among postgraduates.

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4. An ability to design and analyze the various controllers for improvement of performance of Power System & Drives.
5. An ability to develop and apply artificial intelligence based techniques for the analysis of problems related to Power System.
6. Develop confidence for self-study and to engage in lifelong learning.

JBIET Academic Regulations - R22

Applicable to

Master of Technology
(M. Tech)
Regular Two-Year Degree Programme

(For the Batches admitted from the Academic Year 2022- 2023)

J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY

(UGC AUTONOMOUS)

Bhaskar Nagar, Yenkapally (V), Moinabad (M), Hyderabad – 500075, Telangana, India

J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY

(UGC Autonomous)

JBIET Academic Regulations - R22

Applicable to

M. Tech Regular Two-Year Degree Programme

(For the Batches admitted from the Academic Year 2022- 2023)

Offered under **Choice Based Credit System (CBCS)**

1.0 Post-Graduate Degree Programmes in Engineering & Technology (PGP in E & T)

J. B. Institute of Engineering and Technology (JBIET) offers Two Years (Four Semesters) full-time Master of Technology (M. Tech.) Degree programmes, under Choice Based Credit System (CBCS) in the following branches of Engineering and Technology with different specializations as mentioned below:

Computer Science & Engineering	Computer Science & Engineering
Electronics & Communication Engineering	VLSI System Design
Electrical & Electronics Engineering	Electrical Power Systems
Mechanical Engineering	CAD / CAM
Civil Engineering	Structural Engineering

2.0 Eligibility for Admissions

2.1 Admission to the PGPs shall be made subject to eligibility, qualification and specializations prescribed by the University from time to time, for each specialization under each M.Tech programme.

2.2 Admission to the post graduate programme shall be made on the basis of either the merit rank or Percentile obtained by the qualified student in the relevant qualifying GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by Telangana State Government (PGCET) for M.Tech. programmes.

2.3 The medium of instructions for all PG Programmes will be ENGLISH only.

3.0 M.Tech. Programme (PGP in E & T) Structure

3.1 The M.Tech Programmes in E & T of JBIET are of Semester pattern, with Four Semesters consisting of Two academic years, each academic year having Two Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 weeks duration (inclusive of Examinations), with a minimum of 90 instructional

days per Semester.

3.3 UGC/AICTE specified definitions/descriptions are adopted appropriately for various terms and abbreviations used in these PG academic regulations, as listed below:

3.3.1 Semester Scheme

Each Semester shall have 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' and 'COURSE' imply the same meaning here and refer to 'Theory Subject', or 'Lab Course', or 'Seminar', or 'Comprehensive Viva', or 'Project' as the case may be.

3.3.2 Credit Courses

All subjects / courses are to be registered by the student in a semester to earn credits which shall be assigned to each subject/course in an L: T: P: C (Lecture Periods: Tutorial Periods: Practical Periods: Credits) structure based on the following general pattern:

- One credit for one hour/week/semester for theory/lecture (L) courses
- One credit for two hours/ week/semester for laboratory/ practical (P) courses or tutorials
- Other student activities like study tour, guest lecture, conference/workshop participations, technical paper presentations, and identified mandatory courses, if any, will not carry credits.

3.3.3 Mandatory Courses: A student shall register for all mandatory courses mentioned in the curriculum and get minimum pass marks (i.e., 40% of total marks through internal evaluation only) to get the degree. Grade points obtained in these courses will not be considered for awarding class.

3.3.4 Subject Course Classification

All subjects / courses offered for the Post-Graduate Programme in E & T (M.Tech Degree Programme) are broadly classified as follows. The institute has followed in general the guidelines issued by AICTE/UGC.

S. No	Broad Course Classification	Course Group/Category	Course Description
1	Core Courses (CoC)	PC – Professional Core	Includes subjects related to the parent discipline / department/ Branch of Engineering
		Project Work	M. Tech Project or PG Project or Major Project
		Seminar, Technical paper writing	Seminar/Colloquium based on core contents related to parent discipline/department/ Branch of Engineering
		Comprehensive Viva-Voce	Viva-voce covering all the PG subjects studied during the course work and related aspects
2	Elective Courses (EIE)	PE – Program Electives	Includes elective subjects related to the parent discipline/ department/ Branch of Engineering
		OE - Open Electives	Elective subjects which include inter- disciplinary subjects or subjects in an area outside the parent discipline/department/ Branch of Engineering
Total number of Credits = 68			

4.0. Course Registration

4.1 A 'Faculty Advisor or Counselor' shall be assigned to each specialization, who will advise on the Post Graduate Programme (PGP), its Course Structure and Curriculum, Choice/Option for Subjects/ Courses, based on his competence, progress, pre-requisites and interest.

4.2 The Department invites 'Registration Forms' from students. Registration requests for any 'CURRENT SEMESTER' shall be completed BEFORE the commencement of SEEs (Semester End Examinations) of the 'PRECEDING SEMESTER'.

4.3 A Student can apply for Registration, ONLY AFTER obtaining the 'WRITTEN APPROVAL' from his Faculty Advisor, which should be submitted to the Department

4.4 If the Student submits ambiguous choices or multiple options or erroneous entries during Registration for the Subject(s) / Course(s) under a given/ specified Course Group/ Category as listed in the Course Structure, only the first mentioned Subject/ Course in that Category will be taken into consideration.

4.5 Subject/ Course Options exercised through Registration are final and CANNOT be changed, nor can they be inter-changed; further, alternate choices also will not be considered. However, if the Subject/ Course that has already been listed for Registration by the Department in a Semester could not be offered due to unforeseen or unexpected reasons, then the Student will be allowed to have alternate choice either for a new Subject, if it is offered, or for another existing Subject (subject to availability of seats). Such alternate arrangements will be made by the Head of Department, with due notification and time-framed schedule, within the FIRST WEEK from the commencement of Class-work for that Semester.

4.6 Program electives: The students have to choose 5 Program electives (PE-I to V) from the list of program electives given. (2 PEs in I Semester, 2 PEs in II Semester and 1 in III Semester).

4.7 Open electives: The students have to choose one open elective (OE-I) from the list of open electives given in II year I semester.

5.0 Attendance Requirements

The programmes are offered on the basis of a unit system with each subject being considered a unit.

The programmes are offered on the basis of a unit system with each subject being considered a unit.

5.1 A student is eligible to appear for the semester end examinations, if the student acquires a minimum of 75% of attendance in aggregate of all the subjects / courses (excluding attendance in mandatory courses) for that semester..

5.2 Shortage of attendance in aggregate up to 10% (65% and above, and below 75%) in each semester may be condoned on medical grounds.

5.3 Shortage of attendance below 65% in aggregate shall in no case be condoned.

5.4 Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examinations of that semester.

5.5 A student fulfills the attendance requirement in the present semester, shall not be eligible for readmission into the same class.

5.6 A prescribed fee per subject shall be payable for condoning shortage of attendance.

6.0 Academic Requirements

The following academic requirements have to be satisfied, in addition to the attendance requirements mentioned in item no. 5. The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks per subject / course (theory / practical), on the basis of Internal Evaluation and Semester End Examination.

6.1 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/course, if he secures not less than 40% of marks (24 out of 60 marks) in the End Semester Examination, and a minimum of 50% of marks (50 out of 100 marks) in the sum total of CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

6.2 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to a subject/ course, if he secures not less than 50% of the total marks. The student is deemed to have failed, if he (i) does not attend the comprehensive viva-voce as per the schedule given, or (ii) does not present the seminar as required, or (iii) does not present the Technical Paper Writing as required. In such a case, he may reappear for comprehensive viva-voce in supplementary examinations and for seminar/ technical paper writing, in the subsequent semesters, as and when scheduled.

6.3 A student shall register for all subjects for total of 68 credits as specified and listed in the course structure for the chosen specialization, put in required the attendance and fulfill the academic requirements for securing 68 credits obtaining

a minimum of 'B' Grade or above in each subject, and all 68 credits securing Semester Grade Point Average (SGPA) 6.0 (in each semester) and final Cumulative Grade Point Average (CGPA) (i.e., CGPA at the end of PGP) 6.0, to complete the PGP successfully.

6.4 Marks and Letter Grades obtained in all those subjects covering the above specified 68 credits alone shall be considered for the calculation of final CGPA, which will be indicated in the Grade Card /Marks Memo of second year second semester.

6.5 If a student registers for extra subject(s) (in the parent department or other departments/ branches of Engineering) other than those listed subjects totalling to 68 credits as specified in the course structure, the performance in extra subject(s) (although evaluated and graded using the same procedure as that of the required 68 credits) will not be taken into account while calculating the SGPA and CGPA. For such extra subject(s) registered, a certificate will be issued with a letter grade indicated as a performance measure, subject to completion of the attendance and academic requirements as stated in items 5 and 6.1 - 6.3.

6.6 A student eligible to appear for the Semester End Examination in any subject, but absent from it or failed (failing to secure 'B' Grade or above), may reappear for that subject at the supplementary examination as and when conducted. In such cases, his Internal Marks assessed earlier for that subject will be carried over, and added to the marks secured in the supplementary examination, for the purpose of evaluating his performance in that subject.

6.7 A Student who fails to earn 68 credits as per the specified course structure, and as indicated above, within four academic years from the date of commencement of his first year first semester, shall forfeit his seat in M.Tech. programme and his admission shall stand cancelled.

7.0 Evaluation - Distribution and Weightage of Marks

7.1 The performance of a student in every subject/course (including practicals) will be evaluated for 100 marks each, with 40 marks allotted for Continuous Internal Evaluation (CIE) and 60 marks for Semester End Examination (SEE).

7.2 For theory courses, during the semester there is **2 mid-term** examinations (internal exams of **30 marks** each) and **2 assignments** carrying **10 marks** each.

7.3 Each mid-term examination will be of 1 hour 20 minutes consisting of Part-A (short

answer questions) for **10 marks** and Part-B (long answer) for **20 marks**. Part-A consists of Five two marks questions and Part- B consists of five questions carrying 5 marks each and student should answer 4 questions.

7.4 First mid-term examination is conducted from first 2 Modules of syllabus and second mid-term examination is conducted for remaining 3 Modules of syllabus during the last week of instruction.

7.5 The Continuous Internal Evaluation for theory course shall be made as average of marks obtained in CIE – I and CIE –II as detailed in the table below.

CIE – I	Marks	CIE - II	Marks
MID – I	30	MID - II	30
Assignment – I	10	Assignment - II	10
Total	40	Total	40

7.6 If a student is absent for any test/assignment, he is awarded zero marks for that test/assignment. However, a candidate may be permitted on genuine grounds provided he/she has taken permission before the mid-term examination from the Head of the Department. Moreover, he/she has to apply for makeup examinations within a week after completion of mid-term examinations. A subcommittee will be constituted with the following composition to look into such cases.

Subcommittee-composition:

S. No.	Faculty Member	Designation
1	Concern Head of the Department	Chairman
2	Senior faculty nominated by Principal	Member
3	One Senior faculty member of the concern department	Member
4	One faculty member of the other department	Member
5	Additional Controller of Examinations	Member

7.7 The details of the Question Paper pattern for Semester End Examination (Theory) are given below:

The Semester End Examination will be conducted for **60 marks**. It consists of two parts. i).Part A for **10 marks**, ii). Part B for **50 marks**.

- Part-A is a compulsory question which consists of ten sub-questions from all units carrying equal marks.
- Part-B consists of five questions carrying **10 marks** each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

7.8 For practical subjects, **60 marks** shall be awarded for performance in the Semester End Examinations and **40 marks** shall be awarded as Internal Marks. Out of the **40 marks** for internal evaluation, day-to-day work in the laboratory is evaluated for **30 marks** and internal practical examination is evaluated for **10 marks** conducted by the laboratory teacher concerned.

The semester end examination is conducted with an external examiner and the laboratory teacher. The external examiner is selected and appointed by the Principal from the list submitted by Head of the Department

7.9 The semester end examination is conducted with an external examiner and the laboratory teacher. The external examiner is selected and appointed by the Principal from the list submitted by Head of the Department.

7.10 There shall be a Seminar presentation during II Year I semester. For Seminar student under the supervision of a faculty member shall collect literature on a topic and critically review the literature and submit a report to the Department. Upon acceptance of the report by the Department committee candidate shall make an oral presentation before the Department Commitee. The Department Committee comprising of Head of The Department, supervisor, and two other senior faculty members of the Department shall evaluate for 50 marks. There is no external Evaluation for the Seminar.

7.11 There shall be a mini project preferably suggested by the industry of their specialization. The mini project shall be carried out during the summer vacation between I Year II Semester and II year I Semester is evaluated for 50 marks in the II Year I Semester by the Head, Supervisor/ mentor and a senior faculty of the department. A candidate has to secure a minimum of 50% of marks (25 out of 50) to be declared successful. If he fails to obtain the minimum marks, he has to reappear for the same during the supplementary examinations as and when conducted, subject to item 3.2.

7.12 There shall be a dissertation/major project work of one-year duration which contributes strong weightage in the curriculum in the II year. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultation with industry preferably in the region. The planning of laboratory work/modelling/computational work with execution schedule is suggested at the beginning of the programme to ensure expected outcome. This will lead to creation of patents from the result of the programme.

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

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

7.15 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement in all the subjects, both theory and practicals.

7.16 After satisfying 7.15, a candidate has to present in Project Work Review I, in consultation with his Project Supervisor, the title, objective and plan of action of his project work to then Project Work Review Committee (PRC) for approval within four weeks from the commencement of Second Year First Semester. Only after obtaining the approval of the PRC can the student initiate the Project work.

7.17 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the PRC. However, the PRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

7.18 A candidate is permitted to submit Project Thesis only after successful completion of all theory and practical courses with the approval of PRC not earlier than 40 weeks from the date of approval of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the PRC.

7.19 The major project work shall be carried out in two stages: Project Stage – I during II Year I Semester, Project Stage – II during II Year II Semester. Each stage will be evaluated for 100 marks. Student has to submit project work report at the end of each semester. First report includes project work carried out in II Year I semester and second report includes project work carried out in II Year I & II Semesters. SEE for both project stages shall be completed before the commencement of SEE Theory examinations.

7.20 For Project Stage – I, the Project Review Committee shall evaluate the project work for 50 marks and project supervisor shall evaluate for 50 marks. The student is deemed to have failed, if he (i) does not submit a report on Project Stage - I or does not make a presentation of the same before the evaluation committee as per schedule, or (ii) secures less than 50% marks in the sum total of the CIE and SEE taken together. A student who has failed may reappear once for the above evaluation, when it is scheduled again; if he fails in such 'one reappearance' evaluation also, he has to reappear for the same in the next subsequent semester, as and when it is scheduled.

7.21 For Project Stage – II, the external examiner shall evaluate the project work for 50 marks and the project supervisor shall evaluate it for 50 marks. The student is deemed to have failed, if he (i) does not submit a report on Project Stage - II, or does not make a presentation of the same before the external examiner as per schedule, or (ii) secures less than 50% marks in the sum total of the CIE and SEE taken together. For conducting viva-voce of project stage – II, Principal selects an external examiner from the panel of experts in the relevant branch submitted by the HOD.

A student who has failed may reappear once for the above evaluation, when it is scheduled again; if student fails in such 'one reappearance' evaluation also, he has to reappear for the same in the next subsequent semester, as and when it is scheduled.

7.22 After approval from the PRC, the soft copy of the thesis should be submiitted to the Department for ANTI-PLAGIARISM for the quality check and the plagiarism report should be included in the final thesis. If the copied information is less than 30%, then only thesis will be accepted for submission.

7.23 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College, after submission of a research paper related to the project work in a UGC approved journal. A copy of the submitted research paper shall be attached to thesis.

7.24 The Project Viva-Voce External examination marks must be submitted to the Exam Branch on the same day of the examination.

8.0 Re-Admission/Re-Registration

8.1 Re-Admission for Discontinued Student

A student, who has discontinued the M.Tech. degree programme due to any reason whatsoever, may be considered for 'readmission' into the same degree programme (with the same specialization) with the academic regulations of the batch into which he gets readmitted, with prior permission from the authorities concerned, subject to item 6.6.

9.0 Examinations and Assessment - The Grading System

9.1 Grades will be awarded to indicate the performance of each student in each Theory Subject, or Lab/Practicals, or Seminar, or Technical Paper Writing or Project, etc., based on the % of marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Item 7 above, and a corresponding Letter Grade shall be given.

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

% of Marks Secured in a Subject/Course (Class Intervals)	Letter Grade (UGC Guidelines)	Grade Points
Greater than or equal to 90%	O (Outstanding)	10
80 and less than 90%	A+ (Excellent)	9
70 and less than 80%	A (Very Good)	8
60 and less than 70%	B+ (Good)	7
50 and less than 60%	B (Above Average)	6
Below 50%	F (FAIL)	0
Absent	Ab	0

9.3 A student obtaining F Grade in any Subject is deemed to have 'failed' and is required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted. In such cases, his Internal Marks (CIE Marks) in those subjects will remain as obtained earlier.

9.4 If a student has not appeared for the examinations, 'Ab' Grade will be allocated to him for any subject and shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted.

9.5 A Letter Grade does not imply any specific marks percentage; it is only the range of percentage of marks.

9.6 In general, a student shall not be permitted to repeat any Subject/ Course (s) only for the sake of 'Grade Improvement' or 'SGPA/ CGPA Improvement'.

9.7 A student earns Grade Point (GP) in each Subject/ Course, on the basis of the Letter Grade obtained by him in that Subject/ Course. The corresponding 'Credit Points' (CP) are computed by multiplying the Grade Point with Credits for that particular Subject/ Course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

9.8 The student passes the Subject/ Course only when he gets GP ≥ 6 (B Grade or above).

9.9 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (CP) secured from ALL Subjects/ Courses registered in a Semester, by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as

$$SGPA = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} Ci} \text{ for each Semester}$$

where 'i' is the subject indicator index (takes into account all subjects in a semester), 'N' is the no. of subjects 'registered' for the semester (as specifically required and listed under the course structure of the department), C_i is the no. of credits allotted to the i^{th} subject, and G_i represents the grade points (GP) corresponding to the letter grade awarded for that i^{th} subject.

9.10 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered Courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is rounded off to TWO Decimal Places. CGPA is thus computed from the I Year Second Semester onwards, at the end of each Semester, as per the formula

$$\text{CGPA} = \left\{ \frac{\sum_{J=1}^{M} C_J G_J}{\sum_{J=1}^{N} C_J} \right\} \text{..... FOR ALL "S" SEMESTERS REGISTERED}$$

(I.E., UP TO AND INCLUSIVE OF S SEMESTER, S ≥ 2),

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of the parent Department) the Student has 'REGISTERED' for from the 1^{st} Semester onwards up to and inclusive of the Semester S (obviously M > N), 'j' is the Subject indicator index (taking into account all Subjects from 1 to S Semesters), C_i is the no. of Credits allotted to the j^{th} Subject, and C_i represents the Grade Points (GP) corresponding to the Letter Grade awarded for that j^{th} Subject. After registration and completion of I Year I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

Illustration of calculation of SGPA:

Course/Subject	Credits	Letter Grade	Grade Points	Credit Points
Course 1	4	A	8	4 x 8 = 32
Course 2	4	O	10	4 x 10 = 40
Course 3	4	C	5	4 x 5 = 20
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	C	5	3 x 5 = 15
	21			152

$$SGPA = \frac{152}{21} = 7.24$$

Illustration of calculation of CGPA:

Semester	Credits	SGPA	Credits*SGPA
Semester-I	16	7	16 x 7 = 112
Semester-II	18	6	18 x 6 = 108
Semester-III	18	6.5	18x 6.5 = 117
Semester-IV	16	6	16 x 6 = 96
	68		433

$$CGPA = \frac{433}{68} = 6.37$$

10.0 Award of Degree and Class

10.1 If a student who registers for all the specified Subjects/ Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Programme (PGP), and secures the required number of 68 Credits (with CGPA 6.0), shall be declared to have 'QUALIFIED' for the award of the M.Tech. Degree in the chosen Branch of Engineering and Technology with the specialization that he was admitted into.

10.2 Award of Class

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

Class Awarded	CGPA
First Class with Distinction	≥ 7.75
First Class	6.75≤ CGPA < 7.75
Second Class	6.00≤ CGPA < 6.75

A student with final CGPA (at the end of the **PGP) < 6.00** shall not be eligible for the Award of Degree.

11.0 Withholding of Results

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

12.0. Transitory Regulations

12.1 A student who has been detained in any semester of I Year of Previous Regulations due to lack of attendance, shall be permitted to join the same semester of I Year of R22 Regulations and he is required to complete the study of M.Tech programme within the stipulated period of four academic years from the date of first admission in I Year I semester. The R22 Academic Regulations under which a student has been readmitted shall be applicable to that student from that semester.

12.2 For student readmitted to R22 Regulations, the maximum credits that a student acquires for the award of the degree, shall be the sum of the total number of credits secured in previous regulations of his/her study including R22 Regulations.

12.3 If a student readmitted to R22 Regulations, has any subject with 80% of syllabus common with his/her previous regulations, that particular subject in R22 regulations will be substituted by another subject to be suggested by the Concerned Board Of Studies (BOS).

13 General

13.1 The academic regulation should be read as a whole for the purpose of any interpretation.

13.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Institution is final.

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

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	If the student:	
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 student is appearing but has not made use of (material shall include any marks on the body of the student 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 student orally or by any other body language methods or communicates through cell phones with any student or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the students 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 student is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student 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.

3.	Impersonates any other student in connection with the examination.	The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all End examinations. The continuation of the course by the student 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 student 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 student is also debarred for two consecutive semesters from class work and all End examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.

6.	Refuses to obey the orders of the chief superintendent /assistant superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performancein that subject and all other subjects the student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears off the script or any part there of inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student 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 student is also debarred for two consecutive semesters from class work and all End examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.

8.	Possesses 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 student 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 student is also debarred and forfeits the seat.
9.	If student of the college, who is not a student for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student 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 student is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the 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 student has already appeared for including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the student has appeared for including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Examination Result Processing Committee (ERPC) for further action to award a suitable punishment.	

J.B. INSTITUTE OF ENGINEERING AND TECHNOLOGY
(UGC AUTONOMOUS)
Bhaskar Nagar, Moinabad Mandal, R.R. District, Hyderabad -500075

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
M. Tech - ELECTRICAL POWER SYSTEMS (EPS): R-22

CHOICE BASED CREDIT SYSTEM (CBCS)
COURSE STRUCTURE (2022-2023)

I YEAR – I SEMESTER							
Sl. No	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	LM21A	Core1	Advanced Power System Analysis	3	0	0	3
2.	LM21B	Core2	FACTS and Custom Power Devices	3	0	0	3
3.	LM21C LM21D LM21E	PE 1	1. Energy Auditing Conservation & Management 2. Smart-Grids 3. EHVAC Transmission	3	0	0	3
4.	LM21F LM21G LM21H	PE 2	1. Electrical Power Distribution System 2. Industrial Power System Analysis and Design 3. Distribution Automation	3	0	0	3
5.	LM21I	Lab1	Electrical Simulation Lab -1	0	0	4	2
6.	LM21J	Lab2	Power Systems Lab - 1	0	0	4	2
7.	LM91A	MC-I	Soft Skills	2	0	0	0
TOTAL CREDITS				14	0	8	**16**

I YEAR – II SEMESTER							
Sl. No	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	LM22A	Core3	Advanced Power System Protection	3	0	0	3
2.	LM22B	Core4	Power System Operation and Deregulation	3	0	0	3
3.	LM22C LM22D LM22E	PE 3	1. High Voltage Engineering 2. Power Quality 3. HVDC Transmission	3	0	0	3
4.	LM22F LM22G LM22H	PE 4	1. Voltage Stability 2. AI Techniques in Electrical Engineering 3. Reactive Power Compensation and Management	3	0	0	3
5.	LM92A	Core	Research Methodology and IPR	2	0	0	2
6.	LM22I	Lab3	Electrical Simulation Lab - 2	0	0	4	2
7.	LM22J	Lab4	Power Systems Lab - 2	0	0	4	2

8.	LM92B	MC-II	Personality Development and Professional Values	2	0	0	0
TOTAL CREDITS				16	0	8	**18**

II YEAR – I SEMESTER							
Sl. No.	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	LM23A LM23B LM23C	PE 5	1. Electric Vehicles and Power Management 2. Modern Control Theory 3. Distributed Generation and Micro Grid	3	0	0	3
2.	LM2OA LM2OB	OE	1. Renewable Energy Technologies and Battery Storage 2. Solar and Energy Storage Systems	3	0	0	3
3.	LM23D		Mini Project	0	0	4	2
4.	LM23E		Technical Seminar	0	0	2	1
5.	LM23F	Major Project	Phase-I Dissertation	0	0	20	09
TOTAL CREDITS				6	0	26	**18**
II YEAR – II SEMESTER							
Sl. No.	**Code**	**Core/ Elective**	**Course Title**	**L**	**T**	**P**	**C**
1.	LM24A	Major Project	Phase-II Dissertation	0	0	32	16
TOTAL CREDITS				0	0	32	**16**
GRAND TOTAL CREDITS 68							

PE: Program Elective
OE: Open Elective

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year - I Sem			
Course Code: LM21A	CORE 1: ADVANCED POWER SYSTEM ANALYSIS	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Computer Methods in Power Systems

Module 1: Formation of Y_{BUS} [9L]

Unit-I: [5L]

Admittance model and network calculations, Branch and node admittances, mutually coupled branches in Y_{BUS}, An equivalent admittance network, Modification of Y_{BUS}.

Unit-II: [4L]

Network incidence matrix and Y_{BUS}, Method of successive elimination, Node elimination, Triangular factorization, Sparsity and near optimal ordering.

Module 2: Formation of Z_{BUS} [9L]

Unit-I: [4L]

Impedance model and network calculations, Bus admittance and impedance matrices, Thevenin's Theorem and Z_{BUS}

Unit-II: [5L]

Algorithms for building Z_{BUS} modification of existing Z_{BUS}, Calculation of Z_{BUS} elements from Y_{BUS}, Power invariant transformations, Mutually Coupled Branches in Z_{BUS}.

Module 3: Load Flow Analysis [8L]

Unit-I: [4L]

Gauss Seidel method and N-R Method.

Unit-II: [4L]

Decoupled method Fast decoupled method, Comparison between power flow solutions, DC load flow.

Module 4: Contingency Analysis [9L]

Unit-I: [5L]

Z_{BUS} method in Contingency Analysis, Adding and removing multiple lines, Piece-wise solution of interconnected Systems.

Unit-II: [4L]

Analysis of single contingencies, Analysis of multiple contingencies, Contingency analysis of DC Model, System reduction for contingency and fault studies.

Module 5: Fault Analysis [9L]

Unit-I: [5L]

Symmetrical faults, Fault calculations using Z_{BUS}, Fault calculations using Z_{BUS} equivalent circuits.

Unit-II: [4L]

Selection of circuit breakers, Unsymmetrical faults, Problems on various types of faults.

Text Books

1. Pai M A, "Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. HadiSaadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ ADVANCED POWER SYSTEM ANALYSIS.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ ADVANCED POWER SYSTEM ANALYSIS.
4. https://nptel.ac.in/courses.

Course Outcomes

Upon the completion of the subject, the student will be able to

CO 1. Construct network bus admittance matrix using successive elimination, node elimination, and triangular factorization.

CO 2. Construct network bus impedance matrix using Y_{BUS}, bus building algorithm and power invariant transformations with mutually coupled branches.

CO 3. Solve Load Flow problem using Gauss Seidal, N-R and FDLF methods.

CO 4. Analyze single contingency and multiple contingencies using Z_{BUS} method.

CO 5. Make use of Z_{BUS} for symmetrical and unsymmetrical fault calculations.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	1	2
CO2	2	3	3	2	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	2	2	2
Average	2.6	3	3	2.4	1.8	2

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems & Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21B	**CORE 2: FACTS and Custom Power Devices**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Electronics and Power Systems

Module 1: FACTS Concepts [9L]

Unit-I: [4L]

Reactive Power Flow Control in Power Systems: Power flow control, Constraints of maximum transmission line loading, Benefits of FACTS.

Unit-II: [5L]

Transmission line compensation, Uncompensated line, Shunt compensation, Series compensation, Phase angle control, Reactive power compensation, Shunt and Series compensation principles, Reactive compensation at transmission and distribution level.

Module 2: Static Shunt Compensation [9L]

Unit-I: [4L]

Static versus passive VAR compensator, Static shunt compensators.

Unit-II: [5L]

SVC and STATCOM, Operation and control of TSC, TCR and STATCOM Compensator control, Comparison between SVC and STATCOM.

Module 3: Static Series Compensation [8L]

Unit-I: [4L]

TSSC, SSSC -Static voltage and phase angle regulators, TCVR and TCPAR Operation and Control, Applications.

Unit-II: [4L]

Static series compensation, GCSC, TSSC, TCSC and Static synchronous series compensators and their Control.

Module 4: Combined Power Flow Controller [9L]

Unit-I: [4L]

Circuit Arrangement, Operation and control of UPFC.

Unit-II: [5L]

Basic Principle of P and Q control, Independent real and reactive power flow control-Applications, Introduction to interline power flow controller (IPFC)

Module 5: Custom Power Devices [9L]

DSTATCOM - Schematic Diagram and Operation, Topologies - DVR - Schematic Diagram and Operation, Topologies – Applications.

Text Books

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007.
2. 2. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001

E-Resources

1. https://www.sciencedirect.com/topics/engineering/flexible-ac-transmission-systems.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/facts-on-facts-theory-and-applications.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO1. Distinguish the performance of Transmission lines with and without FACTS Devices

CO2. Compare the SVC and STATCOM

CO3. Understand the operation and control of various Static Series Compensators

CO4. Understand the operation and control of the Unified Power Flow Controller

CO5. Summarize the operation and topologies of various Custom Power Devices.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21C	PROGRAM ELECTIVE 1: ENERGY AUDITING, CONSERVATION AND MANAGEMENT	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Electrical Distribution Systems

Module 1: Basic principles of energy audit [9L]

Unit-I: [4L]

Energy audit- Definitions, Concept, Types of audit, Energy index, Cost index, Pie charts, Sankey diagrams, Load profiles.

Unit-II: [5L]

Energy conservation schemes - Energy audit of industries- Energy saving potential, Energy audit of process industry, Thermal power station and Building energy audit.

Module 2: Energy management [9L]

Unit-I: [4L]

Principles of energy management and organizing energy management program**.**

Unit-II: [5L]

Initiating, Planning, Controlling, Promoting, Monitoring, Reporting, Energy manger, Qualities and functions, Language, Questionnaire–Check list for top management.

Module 3: Energy efficient motors [9L]

Unit-I: [5L]

Energy efficient motors, Factors affecting efficiency, Loss distribution and Constructional details.

Unit-II: [4L]

Characteristics - Variable speed, Variable duty cycle systems, RMS HP- Voltage variation- Voltage unbalance- Over motoring- Motor energy audit.

Module 4: Power factor improvement, lighting and energy instruments [9L]

Unit-I: [4L]

Power factor–Methods of improvement, Location of capacitors, Pf with non-linear loads, Effect of harmonics on power factor.

Unit-II: [5L]

Power factor motor controllers - Good lighting system design and practice, Lighting control , Lighting energy audit - Energy instruments- Wattmeter, Data loggers, Thermocouples,

Pyrometers, Lux meters, Tongue testers, Application of PLC's.

Module 5: Economic aspects and analysis [9L]

Unit-I: [5L]

Economics analysis-Depreciation methods, Time value of money, Rate Of return, Present worth method, Replacement analysis, Life cycle costing analysis- Energy efficient motors**.**

Unit-II: [4L]

Calculation of simple payback method, Net present worth method- Power factor correction, Lighting -Applications of life cycle costing analysis, Return on investment.

Text Books

1. W.R. Murphy& G. Mckay,"Energy Management" Butter worth, HeinemannPublications, Second Edition, 2009.
2. Paul o' Callaghan, "Energy Management", Tata Mc-Graw Hill Book Company- FirstEdition, 1998.
3. W.C.Turner, "Energy Management Hand Book", CRC Press, First Edition, 2004.

E-Resources

1) https://www.sciencedirect.com/topics/engineering/ENERGY-AUDITING-CONSERVATION-AND MANAGEMENT.
2) https://digital-library.theiet.org/content/books/po/pbpo030e.
3) https://www.electrical4u.com/facts-on-EACM-theory-and-applications.
4) https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Tell energy audit of industries.

CO 2. Predict management of energy systems.

CO 3. Sequence the methods of improving efficiency of electric motor.

CO 4. Analyze the power factor and to design a good illumination system.

CO 5. Determine pay back periods for energy saving equipment.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1

CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21D	PROGRAM ELECTIVE 1: SMART GRID	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power system - II

Module 1: Introduction to smart grid [9L]

Unit-I: [4L]

Electricity network-Local energy networks- Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid.

Unit-II: [5L]

Smart grid to evolve a perfect power system: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

Module 2: DC distribution and smart grid [9L]

Unit-I: [4L]

AC vs DC sources-Benefits of and drives of DC power delivery systems-Powering equipment and appliances with DC-Data centers and information technology loads-Future neighbourhood-Potential future work and research.

Unit-II: [5L]

Intelligrid architecture for the smart grid: Introduction- Launching intelligrid - Intelligrid today- Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies.

Module 3: Dynamic Energy Systems Concept [8L]

Unit-I: [4L]

Smart energy efficient end use devices - Smart distributed energy resources - Advanced whole building control systems - Integrated communications architecture-Energy management.

Unit-II: [4L]

Role of technology in demand response - Current limitations to dynamic energy management - Distributed energy resources-Overview of a dynamic energy management - Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

Module 4: Energy port as part of the smart grid [9L]

Unit-I: [5L]

Concept of energy-Port, Generic features of the energy port. Policies and programs to encourage end–Use energy efficiency: Policies and programs in action -Multinational – National – State-City and corporate levels.

Unit-II: [4L]

Market implementation: Framework - Factors influencing customer acceptance and response - program planning-monitoring and evaluation.

Module 5: Efficient Electric End – Use Technology Alternatives [9L]

Unit-I: [5L]

Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating- hyper efficient appliances - Ductless residential heat pumps and air conditioners – Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances.

Unit-II: [4L]

Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage -Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

Text Books

1. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response", CRC Press, 2009.
2. JanakaEkanayake, KithsiriLiyanage, Jianzhong. Wu, Akihiko. Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/SMART-GRID.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/SMART GRID.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Apply the concepts of smart grid architecture, dynamic energy systems, energy port in real time applications Integration of smart devices for substation automation.

CO 2. Apply smart grid policies and programs to encourage end – use energy efficiency.

CO 3. Explore the SCADA communication systems.

CO 4. Extend knowledge of substation automation functions and benefits of data warehousing.

CO 5. Interpret the load forecasting and transmission operations and management in real time applications.

CO 6. Integrate DMS framework and real time DMS applications.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21E	**PROGRAM ELECTIVE 1: EHV AC TRANSMISSION**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems - II

Module 1: E.H.V.A.C [9L]

Unit-I: [4L]

Transmission line trends and preliminary aspect standard transmission voltages –Estimation at line and ground parameters

Unit-II: [5L]

Bundle conductor systems-Inductance and Capacitance of E.H.V. lines – Positive, negative and zero sequence impedance – Line Parameters for modes of propagation.

Module 2: Electrostatic field and voltage gradients [9L]

Unit-I: [4L]

Calculations of electrostatic field of AC lines – Effect of high electrostatic field on biological organisms and human beings.

Unit-II: [5L]

Surface voltage gradients and maximum gradients of actual transmission lines – Voltage gradients on sub conductor.

Module 3: Electrostatic induction in unenergized lines [8L]

Unit-I: [4L]

Measurement of field and voltage gradients for three phase single, double circuit lines – Unenergized lines.

Unit-II: [4L]

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.

Module 4: Corona in E.H.V. lines [9L]

Unit-I: [5L]

Corona loss formulae, Attenuation of travelling waves due to corona, Audio noise due to corona, its generation, Characteristic and limits.

Unit-II: [4L]

Measurements of audio noise radio interference due to corona - Properties of radio noise – Frequency spectrum of RI fields –Measurements of RI and RIV.

Module 5: Design of EHV lines [5L]

Unit-I: [5L]

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, Revised Third Edition, 2006.
2. S. Rao, "HVAC and DC Transmission", Khanna Publishers, New Delhi, Third Edition.
3. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, Seventh Printing, Second Edition, 2013.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ EHV AC TRANSMISSION.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ EHV AC TRANSMISSION.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. List the necessity of EHV AC transmission, choice of voltage for transmission, line losses and power handling capability.

CO 2. Estimate the Statistical procedures for line designs, scientific and engineering principles in power systems.

CO 3. Construct commercial transmission system.

CO 4. Knowledge on Corona in E.H.V. lines.

CO 5. Knowledge on Design of EHV lines.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21F	PROGRAM ELECTIVE – 2: ELECTRIC POWER DISTRIBUTION SYSTEM	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Electric Distribution Systems

Module 1: Distribution of power [9L]

Unit-I: [4L]

Distribution of power, Management, Power loads**.**

Unit-II: [5L]

Load forecasting short-term & long-term, power system loading, Technological forecasting.

Module 2: Advantages of Distribution Management System (D.M.S.) Distribution automation [9L]

Unit-I: [4L]

Advantages of Distribution Management System (D.M.S.) Distribution automation, Definition, Restoration / Reconfiguration of distribution network**.**

Unit-II: [5L]

Different methods and constraints power factor correction.

Module 3: Interconnection of distribution, control & communication systems [8L]

Unit-I: [4L]

Interconnection of distribution, control & communication systems, remote metering, Automatic meter reading and its implementation.

Unit-II: [4L]

SCADA: Introduction, Block Diagram, SCADA applied to distribution automation, Common functions of SCADA, Advantages of distribution automation through SCADA.

Module 4: Calculation of optimum number of switches [9L]

Unit-I: [4L]

Calculation of optimum number of switches, Capacitors, Optimum switching device placement in radial and Distribution systems**.**

Unit-II: [5L]

Sectionalizing switches – Types, Benefits, Bellman's optimality principle, Remote terminal units, Energy efficiency in electrical distribution & monitoring.

Module 5: Maintenance of automated distribution systems [9L]

Unit-I: [5L]

Maintenance of automated distribution systems, Difficulties in implementing distribution

Unit-II: [4L]

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., New Delhi, Sixth Edition, 2017.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical Power Distribution Automation", University Science Press, New Delhi, First Edition, 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ELECTRIC-POWER-DISTRIBUTION SYSTEM.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ ELECTRIC POWER DISTRIBUTION SYSTEM.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Knowledge of power distribution system.
CO 2. Study of distribution automation and its application in practice.
CO 3. Learn SCADA system.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	2	1
CO2	3	-	3	3	2	1
CO3	3	-	3	3	2	1
Average	3	-	3	3	2	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the

specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21G	PROGRAM ELECTIVE – 2: INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites:

Module 1: Motor Starting Studies [9L]

Unit-I: [4L]

Introduction: Evaluation Criteria - Starting Methods - System Data-Voltage Drop Calculations**.**

Unit-II: [5L]

Calculation of Acceleration Time - Motor Starting with Limited-Capacity Generators– Computer - Aided Analysis - Conclusions.

Module 2: Power Factor Correction Studies [9L]

Unit-I: [4L]

Introduction: System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis – Voltage Magnification Analysis**.**

Unit-II: [5L]

Sustained Overvoltage's, Switching Surge Analysis, Back-to-Back Switching - Summary and Conclusions.

Module 3: Harmonic Analysis [9L]

Unit-I: [4L]

Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis

Unit-II: [5L]

Acceptance Criteria, Harmonic Filter, Harmonic Evaluation, Case Study, Summary and Conclusions.

Module 4: Flicker Analysis [9L]

Unit-I: [4L]

Sources of Flicker, Flicker Analysis and Flicker Criteria**.**

Unit-II: [5L]

Data for Flicker analysis: Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

Module 5: Insulation and Coordination [9L]

Unit-I: [5L]

Modelling of system; simulation of switching surges; description of EMTP – capabilities

Unit-II: [4L]

Voltage acceptance criteria, insulation coordination case study, methods of minimizing switching transients and conclusions.

Text Books

1. Ramasamy Natarajan, "Computer-Aided Power System Analysis", Marcel Dekker Inc., 2002.
2. EMTP literature from www.microtran.cm
3. IEEE papers on bus transfer.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/INDUSTRIAL-POWER-SYSTEM-ANALYSIS AND DESIGN.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Learners will have knowledge on motor starting and power factor correction.

CO 2. Learners will perform computer-aided harmonic and flicker analysis and to design filters.

CO 3. Learners will have knowledge on various grid grounding methodologies

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21H	PROGRAM ELECTIVE – 2: DISTRIBUTION AUTOMATION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Electrical Distribution Systems

Module 1: Distribution automation and the utility system [9L]

Unit-I: [4L]

Introduction to distribution automation (DA), Control system interfaces, Control and data requirements**.**

Unit-II: [5L]

Centralized vs decentralized control, DA System (DAS), DA hardware, DAS software.

Module 2: Distribution automation functions [9L]

Unit-I: [4L]

DA capabilities, Automation system computer facilities, Management processes, Information management

Unit-II: [5L]

System reliability management, System efficiency management, Voltage management and Load management.

Module 3: Communication systems for DA [9L]

Unit-I: [4L]

DA communication requirements, Communication reliability, Cost effectiveness, Data rate requirements, Two way capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow.

Unit-II: [5L]

Communication systems used in DA: Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio, Microwave satellite, Fiber optics, Hybrid communication systems, Communication systems used in field tests.

Module 4: Technical Benefits [9L]

Unit-I: [4L]

DA benefit categories, Capital deferred savings, Operation and maintenance savings, Interruption related savings, Customer related savings, Operational savings, improved

operation, Function benefits, Potential benefits for functions, and function shared benefits.

Unit-II: [5L]

Guidelines for formulation of estimating equations, Parameters required, Economic impact areas, Resources for determining benefits impact on distribution system, Integration of benefits into economic evaluation.

Module 5: Economic evaluation methods [9L]

Unit-I: [5L]

Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop alternatives, Calculate operating and maintenance costs, Evaluate alternatives. Economic comparison of alternate plans, Classification of expenses and capital expenditures.

Unit-II: [4L]

Comparison of revenue requirements of alternative plans, Book life and continuing plant analysis, Year by year revenue requirement analysis, Short term analysis, End of study adjustment, Break even analysis, Sensitivity analysis computational aids.

Text Books

1. James. Northcote – Green Robert Wilson, "Control and Automation of Electrical Distribution Systems", CRC Press, First Edition, 2007.
2. Biswarup Das, "Power Distribution Automation", Institution of Engineering and Technology (IET) Publishers, Volume 2, 2016.
3. James A. Momoh, "Electric Power Distribution, Protection and Control", CRC Press, First Edition, 2007.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/DISTRIBUTION AUTOMATION.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ DISTRIBUTION AUTOMATION.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Find the transfer of electrical data in distribution system through digital communication.

CO 2. Predict load forecasting and reliability in economic point of view.

CO 3. Apply distribution automation objectives and SCADA.

CO 4. Have knowledge on management of different electrical parameters.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21I	LABORATORY – 1: ELECTRICAL SIMULATION LAB-1	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Simulation program for Y_{BUS} formation.
2. Simulation program for G-S load flow analysis.
3. Simulation program for N-R load flow analysis.
4. Simulation program for FDLF load flow analysis.
5. Simulation program for short circuit analysis.
6. Transient stability analysis for single machine connected to infinite bus by point by point method.
7. Simulation program for generation system reliability analysis.
8. Simulation program for distribution system reliability analysis.
9. Simulink model for a single area load frequency problem and simulate the same.
10. Simulink model for a two area load frequency problem and simulate the same.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Understand/simulate/analyse power system analysis using software.

CO 2. Models of power systems and power electronics.

CO 3. Programs of power system reliability and power electronics.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**1**
CO2	**3**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**3**	**3**	**3**	**2**	**1**
Average	**3**	**3**	**3**	**3**	**2**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-I Sem			
Course Code: LM21J	LABORATORY – 2: POWER SYSTEMS LAB – I	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Determination of sequence impedance of cylindrical rotor synchronous machine.
2. Single line to ground fault (L-G) analysis of cylindrical rotor synchronous machine.
3. Line to line fault (L-L) analysis of cylindrical rotor synchronous machine.
4. Double line to ground fault (L-L-G) analysis of cylindrical rotor synchronous machine.
5. Triple line to ground fault (L-L-L-G) analysis of cylindrical rotor synchronous machine.
6. Determination of sub-transient reactance of a salient pole synchronous machine.
7. Power angle characteristics of salient pole alternator.
8. Demonstrate I-V and P-V Characteristics of PV Module with varying radiations and temperature level.
9. Demonstrate I-V and P-V Characteristics of PV Module with series and parallel combination.
10. Determination of Variation in Tilt Angle on PV Module.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Have knowledge on short circuit analysis.

CO 2. Ability to conduct experiments on synchronous machine to find the characteristics.

CO 3. Able to understand the performance evaluation of various solar equipment's.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.

Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22A	CORE 3: ADVANCED POWER SYSTEM PROTECTION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Switch Gear and Protection.

Module 1: Static relays [9L]

Unit-I: [4L]

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

Unit-II: [5L]

Amplitude comparators: Circulating current type and opposed voltage type, Rectifier bridge comparators, Direct and instantaneous comparators.

Module 2: Phase comparators [9L]

Unit-I: [4L]

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

Unit-II: [5L]

Static over current relays: Instantaneous over current relay, Time over current relays, Basic principles, definite time and inverse definite time over-current relays.

Module 3: Static differential relays [9L]

Unit-I: [4L]

Analysis of static differential relays, Static relay schemes, Duo bias transformer differential protection, Harmonic restraint relay.

Unit-II: [5L]

Static distance relays: Static impedance-reactance, MHO and angle impedance relay, Sampling comparator, Realization of reactance and MHO relay using sampling comparator.

Module 4: Multi-input comparators [9L]

Unit-I: [4L]

Conic section characteristics, Three input amplitude comparator, Hybrid comparator, switched distance schemes, Poly phase distance schemes, phase fault scheme, three phase scheme,

combined and ground fault scheme.

Unit-II: [5L]

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 length and source impedance on distance relays.

Module 5: Microprocessor based protective relays [9L]

Unit-I: [5L]

(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.

Unit-II: [4L]

MHO and offset MHO relays, Realization of MHO characteristics, Realization of offset MHO characteristics, Basic principle of Digital computer relaying.

Text Books

1. Badri Ram and D.N.Vishwakarma, "Power system protection and Switch gear", Tata McGraw Hill Publication, New Delhi, 1995.
2. T.S.Madhava Rao, "Power system protection: Static relays", Tata McGraw Hill Publication, New Delhi, Second edition, 1989.

E-Resources

1. Https://www.sciencedirect.com/topics/engineering/ advanced power system protection.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ADVANCED-POWER SYSTEM AND PROTECTION.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Understand the basic function of a circuit breaker, all kinds of circuit breakers and differentiate fuse and circuit breakers under fault condition.

CO 2. Describe the necessity for the protection of alternators, transformers and feeder bus bars from over voltages and other hazards.

CO 3. Illustrate neutral grounding, and how over voltages can be generated and how system can be protected against lightning and switching transient over voltages with various protective schemes.

CO 4. Identify operation and control of microprocessor based relays.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22B	CORE 4: POWER SYSTEM OPERATION AND DEREGULATION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power systems.

Module 1: Optimal Power Flow [9L]

Introduction - Solution to the optimal power flow - Gradient method - Newton's method - Linear sensitivity analysis - Linear programming methods - Security constrained OPF - Interior point algorithm - Bus incremental costs.

Module 2: Power System Security [9L]

Introduction – Factors affecting power system security-Contingency analysis - Detection of network problems - Linear sensitivity analysis - AC power flow methods - Contingency selection - Concentric relaxation - Bounding area method.

Module 3: State Estimation in Power Systems [9L]

Introduction - Power system state estimation - Maximum likelihood, Weighted least squares estimation - Matrix formulation - State estimation of AC network - State estimation by orthogonal decomposition - detection and identification of Bad measurements - Estimation of quantities not being measured - Network observability and pseudo measurements.

Module 4: Power System Deregulation [9L]

Introduction - motivation for restructuring of power systems - Electricity market entities model benefits of deregulation – Terminology - Deregulation in Indian power sector - Operations in power markets - Power pools - Transmission networks and electricity markets.

Module 5: Available Transfer Capability [9L]

Introduction methods of determination of ATC - ATC calculation considering the effect of contingency analysis - Transmission open access and pricing-Cost components of transmission system - Transmission pricing methods - Incremental cost based transmission pricing.

Text Books

1. Wood, A. J., Wollenberg, B. F., &Sheblé, G. B. 'Power Generation, operation and control', John Wiley &Sons, 2013.

2. T.K.Nagsarkar, M.S.Sukhija, 'Power system analysis', Oxford publications, 2007.

E-Resources

1) Https://www.sciencedirect.com/topics/engineering/real-time-applications-for-power systems.
2) https://digital-library.theiet.org/content/books/po/pbpo030e.
3) https://www.electrical4u.com/real-time-applications-for-power systems.
4) https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Understand the study of optimal power flows

CO 2. Discuss the power system security and challenges in secured operation of power system in real-time environment.

CO 3. Acquire knowledge of state estimation required for the real-time operation of power system.

CO 4. Understand the concept of Power System Deregulation.

CO 5. Analyze ATC and the cost of transmission.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22C	PROGRAM ELECTIVE – 3: HIGH VOLTAGE ENGINEERING	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems and Electrical & Electronics Instrumentation.

Module 1: Introduction to high voltage engineering [9L]

Unit-I: [4L]

Electric field stresses, Gas / Vacuum as insulator, Liquid dielectrics, Solids and composites, Estimation and control of electric stress, Numerical methods for electric field computation**.**

Unit-II: [5L]

Surge voltages their distribution and control, Applications of insulating materials in transformers, Rotating machines, Circuit breakers, Cable power capacitors and bushings.

Module 2: Break down in dielectric materials [9L]

Unit-I: [4L]

Gases as insulating media, Collision process, Ionization process, Townsend's criteria of breakdown in gases**,** Paschen's law.

Unit-II: [5L]

Liquid as Insulator, pure and commercial liquids, Break down in pure and commercial liquids. Intrinsic breakdown, Electro mechanical breakdown, Thermal break down, Breakdown of solid dielectrics in practice, Breakdown in composite dielectrics, Solid dielectrics used in practice.

Module 3: Generation & measurement of high voltages & currents [9L]

Unit-I: [4L]

Generation of high direct current voltages, Generation of high alternating voltages, Generation of impulse voltages, Generation of impulse currents, Tripping and control of impulse generators

Unit-II: [5L]

Measurement of high DC voltages, Measurement of high voltages alternating and impulse, Measurement of direct alternating and impulse, Oscilloscope for impulse voltage and current measurements.

Module 4: Over voltages & insulation co-ordination [9L]

Unit-I: [4L]

Natural causes for over voltages: Lightning phenomenon, Overvoltage due to switching

surges, System faults and other abnormal conditions**.**

Unit-II: [5L]

Principles of insulation coordination on high voltage and extra high voltage power systems.

Module 5: Testing of materials & electrical apparatus [9L]

Unit-I: [5L]

Measurement of D.C Resistivity, Measurement of dielectric constant, loss factor and Partial discharge measurements.

Unit-II: [4L]

Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of transformers, Testing of surge arresters and Radio interference measurements.

Text Books

1. M.S.Naidu and V. Kamaraju,"High Voltage Engineering" Tata McGraw HillPublications, Fifth Edition, 2013.
2. E.Kuffel, W.S.Zaengl, J.Kuffel, "High Voltage Engineering: Fundamentals", Elsevier, Second Edition, 2000.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ HIGH-VOLTAGE-ENGINEERING.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ HIGH VOLTAGE ENGINEERING.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Know conduction and breakdown will occur in gases, liquids and solids dielectrics, and different applications of the insulating materials in electrical power apparatus.

CO 2. Explain the insulation testing of various components in power systems for different types of voltages, namely power frequency A.C, high frequency, switching or lightning impulses, for which generation of high voltages in laboratories is essential.

CO 3. Interpret the necessity to measure the voltages and currents accurately, ensuring perfect safety to the personnel and equipment.

CO 4. Detect the necessary condition for all the electrical equipment which are capable of withstanding the over voltages which met in service like natural causes lightning or system originated ones switching or power frequency transient voltage.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

7.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22D	PROGRAM ELECTIVE 3: POWER QUALITY	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems and Power Electronics.

Module 1: Introduction to Power Quality [9L]

Unit-I: [4L]

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption**.**

Unit-II: [5L]

Overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

Module 2: Long & short interruptions [9L]

Unit-I: [4L]

Long interruptions – Definition – Difference between failures, outage, Interruptions – 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-II: [5L]

Short interruptions: Definition, Origin of short interruptions, Basic principle, Fuse 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 and current at post fault period, Stochastic prediction of short interruptions.

Module 3: 1 & 3-Phase voltage sag characterization [9L]

Unit-I: [4L]

Voltage sag – Definition, Causes of voltage sag, Voltage sag magnitude, and monitoring, Theoretical calculation of voltage sag magnitude, Voltage sag calculation in non-radial systems, Meshed systems, and voltage sag duration.

Unit-II: [5L]

Three phase faults, Phase angle jumps, Magnitude and phase angle jumps for three phase unbalanced sags, Load influence on voltage sags.

Module 4: Power quality considerations in industrial power systems [9L]

Unit-I: [4L]

Voltage sag, Equipment behavior of power electronic loads, Induction motors, Synchronous motors, computers, Consumer electronics, Adjustable speed AC drives and its operation.

Unit-II: [5L]

Mitigation of AC Drives, Adjustable speed DC drives and its operation, Mitigation methods of DC drives.

Module 5: Mitigation of interruptions & voltage sags [9L]

Unit-I: [5L]

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 controller, combined shunt and series controller.

Unit-II: [4L]

PQ and EMC standards: Introduction to standardization, IEC electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

Text Books

1. Math H J Bollen, "Understanding Power Quality Problems" Wiley Publications, Volume 5, 2000.
2. C. Sankaran, "Power Quality", CRC Presss, First Edition, 2002.
3. Alexander Kusko, Marc Thompson, "Power Quality in Electrical Systems", Tata McGraw Hill Publishing Co. Ltd., New Delhi, First Edition, 2007.
4. Surajit Chattopadhyay, MadhuchhandaMitra, Samarjit Sengupta, "Electric Power Quality", Springer, First Edition, 2007.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ POWER QUALITY.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ POWER QUALITY.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

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

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

CO 3. Compute the concept of improving the power quality to sensitive load by various mitigating custom power devices.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22E	PROGRAM ELECTIVE – 3: HVDC TRANSMISSION	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems and Power Electronics.

Module 1: Introduction to HVDC Transmission [4L]

Unit-I: [4L]

General consideration, Power handling capabilities of HVDC Lines, Basic Conversion principles and Static converter configuration.

Module 2: Static power converters [9L]

Unit-I: [4L]

3-pulse, 6-pulse, and 12-pulse converters, Converter station and Terminal equipment, Commutation process, Rectifier and inverter operation**,** Equivalent circuit for converter – Special features of converter transformers.

Unit-II: [5L]

Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

Module 3: Control of HVDC converters and Systems [9L]

Unit-I: [4L]

Constant current, constant extinction angle and constant ignition angle control, Individual phase control and equidistant firing angle control DC power flow control.

Unit-II: [5L]

Interaction between HVAC and DC systems Voltage interaction, Harmonic instability problems and DC power modulation.

Module 4: MTDC systems& over voltages [9L]

Unit-I: [4L]

Series parallel and series parallel systems their operation and control.

Unit-II: [5L]

Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

Module 5: Converter faults & protection [5L]

Unit-I: [5L]

Converter faults, over current protection – Valve group, and DC line protection over voltage protection of converters, Surge arresters.

Text Books

1. E.W. Kimbark, "Direct Current Transmission", Wiley Inter Science, New York, Volume 1, 1971.
2. KR Padiyar, "High Voltage Direct current Transmission", New Age International Publishers, First Edition Reprint, 1992.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ HVDC TRANSMISSION.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ HVDC TRANSMISSION.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Compare the differences between HVDC and HVAC transmission.

CO 2. Analyze the rectifier and inverter commutating circuits.

CO 3. Identification of valve firing control schemes.

CO 4. Estimate the requirement of HVDC filters.

CO 5. Address the role of AC system faults on HVDC system.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the

specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.

4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22F	**PROGRAM ELECTIVE 4: VOLTAGE STABILITY**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Computers Methods in Power Systems.

Module 1: Introduction to voltage stability [9L]

Unit-I: [4L]

Voltage stability, Voltage collapse, Voltage security, Physical relation indicating dependency of voltage on reactive power flow.

Unit-II: [5L]

Factors affecting voltage collapse and instability, previous cases of voltage collapse incidences.

Module 2: Graphical analysis of voltage stability [9L]

Unit-I: [4L]

Comparison of voltage and angular stability of the system; Graphical methods describing voltage collapse phenomenon

Unit-II: [5L]

P-V and Q-V curves, detailed description of voltage collapse phenomenon with the help of Q-V curves.

Module 3: Analysis of voltage stability [9L]

Unit-I: [4L]

Analysis of voltage stability on SMLB system: Analytical treatment and analysis.

Unit-II: [5L]

Voltage stability indices: Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stability margin.

Module 4: Power system loads [9L]

Unit-I: [4L]

Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heat pumps, electronic power supplies, OH lines and cables.

Unit-II: [5L]

Reactive power compensation: Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous condensers, SVCs; OLTCs; Booster Transformers.

Module 5: Voltage stability margin [5L]

Unit-I: [5L]

Stability Margin: Compensated and un-compensated systems. Voltage Security: Definition; Voltage security; Methods to improve voltage stability and its practical aspects.

Text Books

1. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwerpublishers, 1998.
2. P. Kundur, "Power System Stability and Control", Tata McGraw-Hill PublishingCompany Ltd., New Delhi, 1993.
3. Carson W. Taylor, "Power System Voltage Stability", McGraw-Hill Ryerson, Limited, 1994.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/VOLTAGE STABILITY.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/VOLTAGE STABILITY.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Summarize theoretical background of voltage stability.

CO 2. Illustrate voltage stability analysis using P-V and Q-V curves.

CO 3. Apply analytical methods for voltage stability analysis.

CO 4. Understand the basic concept and types of reactive power compensation.

CO 5. Compute voltage stability margin for voltage stability improvement.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22G	PROGRAM ELECTIVE 4: AI TECHNIQUES IN ELECTRICAL ENGINEERING	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Computers Methods in Power Systems.

Module 1: Artificial neural networks [9L]

Unit-I: [4L]

Introduction - Models of neural network - Architectures – Knowledge representation – Artificial intelligence and neural networks.

Unit-II: [5L]

Learning process – Error correction learning – Hebbian learning –Competitive learning – Boltzmann learning –Supervised learning – Unsupervised learning– Reinforcement learning.

Module 2: ANN Paradigms [4L]

Unit-I: [4L]

ANN Paradigms: Multi – layer perception using Back propagation algorithm, Self – organizing Map – Radial basis function network – Functional link, network – Hopfield network.

Module 3: Fuzzy logic [9L]

Unit-I: [4L]

Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic fuzzy set operations – Properties of fuzzy sets – Fuzzy Cartesian product.

Unit-II: [5L]

Operations on fuzzy relations– Fuzzy logic – Fuzzy quantifiers-Fuzzy inference-Fuzzy rule based system-De fuzzification methods.

Module 4: Genetic Algorithms [9L]

Unit-I: [4L]

Introduction - Encoding – Fitness function-Reproduction operators - Genetic modelling – Genetic operators – Crossover- Single – Site crossover-Two point crossover –Multi point crossover-Uniform crossover – Matrix crossover - Crossover rate-Inversion &deletion.

Unit-II: [5L]

Mutation operator – Mutation – Mutation rate – Bit - wise operators-Generational cycle-convergence of genetic algorithm.

Module 5: Applications of AI techniques [9L]

Unit-I: [4L]

Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system.

Unit-II: [5L]

Small signal stability (Dynamic stability), Reactive power control, Speed control of DC and AC Motors.

Text Books

1. S.Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"- PHI, New Delhi, 2003.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/AI-TECHNIQUES-IN-ELECTRICAL ENGINEERING.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/facts-on-facts-theory-and-applications.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Define the advances in neural networks.

CO 2. Evaluate the design and control of fuzzy systems.

CO 3. Evaluate the design of various models in neural networks.

CO 4. Analyze the techniques of various types of neural networks.

CO 5. Design fuzzy logic system.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**3**	**1**
CO2	**3**	**-**	**3**	**3**	**3**	**1**
CO3	**3**	**-**	**3**	**3**	**3**	**1**
CO4	**3**	**-**	**3**	**3**	**3**	**1**
CO5	3	-	3	3	**3**	1
Average	**3**	**-**	**3**	**3**	**3**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22H	PROGRAM ELECTIVE 4: REACTIVE POWER COMPENSATION AND MANAGEMENT	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Reactive Power Compensation and Management.

Module 1: Load Compensation [4L]

Unit-I: [4L]

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.

Module 2: Steady state reactive power compensation in transmission system [9L]

Unit-I: [4L]

Uncompensated line – Types of compensation – Passive shunt and series and dynamic shunt compensation –Examples.

Unit-II: [5L]

Transient state reactive power compensation in transmission systems: Characteristic time periods – Passive shunt compensation – Static compensations- Series capacitor compensation –Compensation using synchronous condensers – Examples.

Module 3: Reactive Power Coordination [5L]

Unit-I: [5L]

Objective – Mathematical modelling – Operation planning – Transmission benefits – Basic concepts of quality of power supply – Disturbances- steady –State Variations – Effects of under voltages – Frequency –Harmonics, RF and electromagnetic interferences.

Module 4: Demand side management [9L]

Unit-I: [4L]

Load patterns – Basic methods load shaping – Power tariffs- KVAR based tariffs penalties for voltage flickers and harmonic voltage levels.

Unit-II: [5L]

Distribution side reactive power management: System losses –Loss reduction methods – Examples – Reactive power planning – Objectives –Economics Planning capacitor placement – Retrofitting of capacitor banks.

Module 5: User side reactive power management [9L]

Unit-I: [4L]

KVAR requirements for domestic appliances – Purpose of using capacitors – Selection of capacitors – Deciding factors – Types of available capacitor, characteristics and Limitations.

Unit-II: [5L]

Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – Reactive power control requirements – Distribution transformers- Electric arc furnaces – Basic operations- Furnaces transformer –Filter requirements – Remedial measures –Power factor of an arc furnace.

Text Books

1. T.J.E.Miller, "Reactive Power Control in Electric Power Systems", John Wiley and Sons, 1982.
2. D.M.Tagare, "Reactive Power Management", Tata McGraw Hill, F8irst Reprint, 2007.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/REACTIVE POWER COMPENSATION AND MANAGEMENT.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/REACTIVE POWER COMPENSATION AND MANAGEMENT.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Evaluate the design and control of different types of compensation.

CO 2. Articulate User side reactive power management.

CO 3. Articulate steady state and transient state reactive power compensation.

CO 4. Techniques for analyzing of reactive power management.

CO 5. Evaluate reactive power control requirements.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**3**	**1**
CO2	**3**	**-**	**3**	**3**	**3**	**1**
CO3	**3**	**-**	**3**	**3**	**3**	**1**
CO4	**3**	**-**	**3**	**3**	**3**	**1**
CO5	3	-	3	3	**3**	1
Average	**3**	**-**	**3**	**3**	**3**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak.

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22I	LABORATORY – 3: ELECTRICAL SIMULATION LAB-2	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Modelling of single area and multi-line Load frequency control in MATLAB SIMULINK.
2. Modelling AVR in MATLAB SIMULINK.
3. Modelling IEEE excitation systems in MATLAB SIMULINK.
4. Study of effect of Faults (LG, LL, LLG, 3 phase) on a single machine connected to infinite Bus.
5. Representation of Sequence Networks.
6. Modelling of Turbine and Governor System
7. Solution of Swing Equation by any one method.
8. Simulation of Single phase full converter using RL and E loads.
9. Simulation of Three phase full converter using RL and E loads.
10. Simulation of Single phase AC Voltage controller using RL load.
11. Simulation of Three phase inverter with PWM controller.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Express economic operation of power system and importance of LFC control.

CO 2. Improve student's ability in solving problems related to Economic Load Dispatch, Load Frequency Control and reactive power control.

CO 3. Ability to discuss single area load frequency control and two area load frequency control.

CO 4. Ability to model and design turbine and automatic controller.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**
Average	**3**	**3**	**3**	**3**	**2**	**2**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS I Year-II Sem			
Course Code: LM22J	LABORATORY – 4: Power Systems Lab-2	L	T	P	C
Credits: **2**		**0**	**0**	**4**	**2**

List of the Experiments:

1. Determination of Equivalent circuit of a 3-Winding Transformer.
2. Determination of Sequence Impedances of Three Phase Transformer.
3. Characteristics of Over Current Electromagnetic Relay (7051 A).
4. Characteristics of Over Current Microprocessor based Relay (7051 B).
5. Characteristics of Over Voltage Electromagnetic Relay (7053 A).
6. Characteristics of Over Voltage Microprocessor based relay (7053 B).
7. Characteristics of Under Voltage and Negative Sequence Relays (i) UV Electromagnetic Relay (7052 A) (ii) Static Negative Sequence Relay (7055 B).
8. Characteristics of Under Voltage Microprocessor Based Relay (7052 B).
9. Performance and Testing of Feeder Protection System.
10. Performance and Testing of Transmission Line Model.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Test and evaluate the performance of Power Transformers.

CO 2. Test and evaluate the performance of Transmission lines.

CO 3. Evaluate/Choose the various types of Relays (Electromagnetic, Static and Microprocessor based relays).

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**
Average	**3**	**3**	**3**	**3**	**2**	**2**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM23A	PROGRAM ELECTIVE 5: ELECTRIC VEHICLES AND POWER MANAGEMENT	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power Systems.

Module 1: ELECTRIC VEHICLES AND VEHICLE MECHANICS [9L]

Unit-I: [9L]

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV With internal combustion Engine vehicles, Fundamentals of vehicle mechanics.

Module 2: ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS [9L]

Unit-I: [9L]

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) - Power train Components and sizing, Gears, Clutches, Transmission and Brakes.

Module 3: CONTROL OF DC AND AC DRIVES [9L]

Unit-I: [4L]

DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (Motoring and braking) of induction motor drive system**.**

Unit-II: [5L]

Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives.

Module 4: BATTERY ENERGY STORAGE SYSTEM [9L]

Unit-I: [9L]

Battery Basics, Different types, Battery Parameters, Battery modelling, Traction Batteries.

Module 5: ALTERNATIVE ENERGY STORAGE SYSTEMS [9L]

Unit-I: [9L]

Fuel cell – Characteristics- Types – hydrogen Storage Systems and Fuel cell EV – Ultra Capacitors.

Text Books

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second

Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2. 2 Ali Emadi, MehrdadEhsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/ELECTRIC-VEHICLES-AND-POWER-MANAGEMENT.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/ ELECTRIC-VEHICLES-AND-POWER-MANAGEMENT.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Understand the operation of Electric vehicles and various energy storage technologies for electrical vehicles.

CO 2. Knowledge on architecture of EV's and power train components.

CO 3. Knowledge on control of dc and ac drives.

CO 4. Understanding the battery energy storage system.

CO 5. Knowledge on alternative energy storage systems.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the

performance of Power systems& Drives.

5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	**J. B. Institute of Engineering and Technology** (UGC Autonomous)	**M. Tech EPS II Year-I Sem**			
Course Code: LM23B	**PROGRAM ELECTIVE 5: MODERN CONTROL THEORY**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Control Systems

Module 1: State variable analysis [9L]

Unit-I: [4L]

The concept of state – State equations for dynamic systems– Time invariance and linearity – Non-uniqueness of state model – State diagrams for continuous - Time state models.

Unit-II: [5L]

Linear continuous time models for physical systems – Existence and uniqueness of solutions to continuous - Time state equations – Solutions of linear time invariant continuous - Time state equations – State transition matrix and its properties.

Module 2: State variable analysis & design [9L]

Unit-I: [4L]

General concept of controllability – General concept of observability – Controllability tests for continuous -Time invariant systems – Observability tests for continuous**.**

Unit-II: [5L]

Time invariant systems – Controllability and observability of state model in Jordan Canonical form – Controllability and observability canonical forms of state model.

Module 3: Non - linear systems [9L]

Unit-I: [5L]

Introduction – Non-linear systems - Types of non-linearity's – Saturation – Dead-Zone - Backlash – Jump phenomenon etc.; – Singular points.

Unit-II: [4L]

Introduction to linearization of non - linear systems, Properties of non-linear systems, Describing function, Describing function analysis of non-linear systems, Stability analysis of non-linear systems through describing functions.

Module 4: Phase plane methods [9L]

Unit-I: [9L]

Introduction to phase-plane analysis, Method of isoclines for constructing trajectories, Singular points, Phase-plane analysis of non-linear control systems.

Module 5: Stability analysis [9L]

Unit-I: [4L]

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 – Variable gradient method – Krasooviski's method.

Unit-II: [5L]

State feedback controller design through pole assignment – State observers: Full order and reduced order.

Text Books

1. M.Gopal, "Modern Control System Theory", New Age International, Revised Second Edition, 1993.
2. OgataKatsuhiko, "Modern Control Engineering", Pearson Education Publication, Fifth Edition, 2010.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/MODERN CONTROL THEORY.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/MODERN CONTROL THEORY.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Apply the knowledge of basic and modern control system for the real time analysis.

CO 2. Design the real time control systems.

CO 3. Understand the concepts of state variables analysis.

CO 4. Analyse the concept of stability of nonlinear systems.

CO 5. Get the knowledge on phase plane methods.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1

CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM23C	**PROGRAM ELECTIVE 5: DISTRIBUTED GENERATION AND MICRO GRID**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Control Systems

Module 1: Need for Distributed Generation [9L]

Unit-I: [9L]

Renewable sources in distributed generation - Current scenario in distributed generation - Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems.

Module 2: Grid Integration of DGs [9L]

Unit-I: [4L]

Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units.

Unit-II: [5L]

Energy storage elements - Batteries, ultra capacitors, flywheels.

Module 3: Technical Impacts of DGs [9L]

Unit-I: [9L]

Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems.

Module 4: Economic and Control Aspects of DGs [9L]

Unit-I: [9L]

Market facts, issues and challenges - Limitations of DGs - Voltage control techniques, Reactive power control, Harmonics, Power quality issues - Reliability of DG based systems – Steady state and Dynamic analysis.

Module 5: Introduction to Micro-grids [9L]

Unit-I: [4L]

Types of micro-grids – Autonomous and non-autonomous grids – Sizing of micro-grids - Modeling & analysis - Micro-grids with multiple DGs.

Unit-II: [5L]

Micro-grids with power electronic interfacing units - Transients in micro-grids - Protection of micro-grids – Case studies.

Text Books

1. H. Lee Willis, Walter G. Scott, 'Distributed Power Generation – Planning and Evaluation', Marcel Decker Press, 2000.
2. M.GodoySimoes, Felix A.Farret, 'Renewable Energy Systems – Design and Analysis with Induction Generators', CRC press.
3.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/DISTRIBUTED-GENERATION-AND-MICRO GRID.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/DISTRIBUTED GENERATION AND MICRO GRID.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Find the size and optimal placement DG

CO 2. Analyze the impact of grid integration and control aspects of DGs

CO 3. Model and analyze a micro grid taking into consideration the planning and Operational issues of the DGs to be connected in the system

CO 4. Describe the technical impacts of DGs in power systems.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to

solve practical problems.

2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM2OA	**OPEN ELECTIVE - RENEWABLE ENERGY TECHNOLOGIES AND BATTERY STORAGE SYSTEMS**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Renewable Energy Sources.

Module 1: Fundamentals of Energy [9L]

Unit-I: [4L]

Energy consumption and standard of living, Oil crisis, Classification of energy resources, Consumption trend of primary energy resources, conventional energy sources and their distribution, Energy chain, common forms of energy.

Unit-II: [5L]

Importance and salient features of nonconventional energy resources, environmental aspects of energy, Environment-economy-energy and sustainable development, Energy densities of various fuels, World energy status, Energy scenario in India.

Module 2: Solar energy [9L]

Unit-I: [4L]

Solar energy basics, Sun - Earth relation spectrum, Terrestrial and extra- terrestrial radiation, spectral energy distribution of solar radiation and Depletion of solar radiation**.**

Unit-II: [5L]

measurement of solar radiation, solar radiation data, Solar time, Solar radiation geometry, Solar day length, Empirical equations for estimation of solar radiation on horizontal surfaces, Global, diffused and beam radiation, Solar radiation on inclined surface (Problems on energy availability on surfaces).

Module 3: Wind Energy [9L]

Unit-I: [4L]

Wind origin, nature, types, Wind data and wind rose, wind speed variation, Wind siting Wind turbine classification and types of rotors, Wind turbine aerodynamics, power extraction from wind, Betz criteria, Axial thrust on the turbine.

Unit-II: [5L]

torque developed by the turbine, Dynamic matching, speed control strategies, Wind turbine operational characteristics, wind energy conversion systems, environmental aspect, Wind energy potential and installation in India (Problems on energy Conversion).

Module 4: Biomass Energy [9L]

Unit-I: [4L]

Biomass resources and their classification**,** Biomass conversion technologies: Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – operational parameters of biogas plants.

Unit-II: [5L]

Types of biogas Plants and biogas plant design – Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy program in India (Problems on biogas plant design)

Module 5: Electrical Energy Storage Technologies [9L]

Unit-I: [9L]

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Text Books

1. Renewable Energy Sources, Twidell, J.W. and Weir, A., EFN Spon Ltd., 1986.
2. Renewable Energy Engineering and Technology, Kishore VVN, Teri Press, New Delhi, 2012
3. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/Fundamentals of Energy.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/Fundamentals of Energy.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. An understanding of renewable energy sources.

CO 2. Knowledge of working principle of various energy systems.

CO 3. A capability to carry out basic design of certain renewable energy systems.

CO 4. Analyze the characteristics of energy from various sources and need for storage.

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	1
CO2	3	-	3	3	-	1
CO3	3	-	3	3	-	1
CO4	3	-	3	3	-	1
Average	3	-	3	3	-	1

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.

AY: 2022-23 Onwards	J. B. Institute of Engineering and Technology (UGC Autonomous)	M. Tech EPS II Year-I Sem			
Course Code: LM2OB	**OPEN ELECTIVE – SOLAR AND ENERGY STORAGE SYSTEMS**	L	T	P	C
Credits: **3**		**3**	**0**	**0**	**3**

Pre-Requisites: Power systems and renewable energy sources.

Module 1: Introduction [9L]

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell Properties – PV cell interconnection.

Module 2: Stand Alone PV System [9L]

Solar modules – storage systems – power conditioning and regulation - MPPT- protection – stand-alone PV systems design – sizing.

Module 3: Grid Connected PV Systems [9L]

PV systems in buildings – design issues for central power stations – safety – Economic Aspect – Efficiency and performance - International PV programs.

Module 4: Energy Storage Systems [9L]

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage.

Module 5: Applications [9L]

Water pumping – battery chargers – solar car – direct-drive applications – Space – Tele communications.

Text Books

1. Solanki C.S., "Solar Photovoltaics: Fundamentals, Technologies And Applications", PHI Learning Pvt. Ltd.,2015.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, "Applied Photovoltaics", 2007,Earthscan, UK. Eduardo Lorenzo G. Araujo, "Solar electricity engineering of photovoltaic systems", Progensa,1994.
3. Frank S. Barnes & Jonah G. Levine, "Large Energy storage Systems Handbook", CRC Press, 2011.
4. McNeils, Frenkel, Desai, "Solar & Wind Energy Technologies", Wiley Eastern, 1990.

5. S.P. Sukhatme , "Solar Energy", Tata McGraw Hill,1987.

E-Resources

1. https://www.sciencedirect.com/topics/engineering/SOLAR-AND-ENERGY-STORAGE SYSTEMS.
2. https://digital-library.theiet.org/content/books/po/pbpo030e.
3. https://www.electrical4u.com/SOLAR AND ENERGY STORAGE SYSTEMS.
4. https://nptel.ac.in/courses.

Course Outcomes

At the end of the course, the student will be able to:

CO 1. Develop more understanding on solar energy storage systems

CO 2. Develop basic knowledge on standalone PV system

CO 3. Understand the issues in grid connected PV systems

CO 4. Study about the modelling of different energy storage systems and their performances

CO 5. Attain more on different applications of solar energy

CO-PO/PSO Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**-**	**3**	**3**	**-**	**1**
CO2	**3**	**-**	**3**	**3**	**-**	**1**
CO3	**3**	**-**	**3**	**3**	**-**	**1**
CO4	**3**	**-**	**3**	**3**	**-**	**1**
CO5	3	-	3	3	-	1
Average	**3**	**-**	**3**	**3**	**-**	**1**

Correlation: 3–Strong; 2–Medium; 1-Weak

Program Outcomes (Pos)

1. An ability to independently carry out research /investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program.
4. An ability to design and analyze the various controllers for improvement of the performance of Power systems& Drives.
5. An ability to develop and apply artificial intelligence-based techniques for the analysis of problems related to Power systems.
6. Develop confidence for self-study and engage in lifelong learning.