B.S. Abdur Rahman ™
Crescent
Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2022
Curriculum and Syllabi
(As approved by the 20th Academic Council)
April - 2023

M.Tech.
(Power System Engineering)

B.S. Abdur Rahman ™
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REGULATIONS 2022

CURRICULUM AND SYLLABI

(Updated upto April 2023, as per 20th Academic Council)

M.TECH. POWER SYSTEMS ENGINEERING

VISION AND MISSION OF THE INSTITUTION

VISION

B.S.Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION

VISION

To achieve excellence in the programs offered by the Department of Electrical and Electronics Engineering through quality teaching, holistic learning and innovative research.

MISSION

- To offer Under Graduate, Post Graduate & Research programs of industrial and societal relevance.
- To provide knowledge and skill in the Design and realization of Electrical and Electronic circuits and systems.
- To impart necessary managerial and soft skills to face the industrial challenges.
- To pursue academic and collaborative research with industry and research institutions in India and abroad.
- To disseminate the outcome of research and projects through publications, seminars and workshops.
- To provide conducive ambience for higher education, teaching and research.

PROGRAMME EDUCATIONAL OBJECTIVES:

- To develop competent and skilled power system engineers to meet the national and international industrial requirements.
- To meet the day to day challenges faced by the power sector due to deregulation and to equip the students in power system software applications.
- To meet the challenges of today's clean energy sector and to contribute to the environmental social concerns.
- To train the students to realistic industrial environment, meeting the modern engineering practices.

PROGRAMMEOUTCOMES:

1. **Engineering knowledge**:
   Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**:
   Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**:
   Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**:
   Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**:
   Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**:
   Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**:
   Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**:
   Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**:
   Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**:
    Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to

comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**:
    Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**:
    Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES:

(i) Ability to provide solutions for power system problems to meet global requirements

(ii) Have ability to apply various industrial power system software packages in the areas of planning and operation of power systems.

(iii) To have a substantial knowledge, in emerging areas such as deregulation of power system, smart grid and clean energy.

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS 2022

M.Tech. / MCA / M.Sc. / M.Com. / M.A. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

i) **"Programme"** means post graduate degree programme (M.Tech. / MCA / M.Sc. / M.Com. / M.A.)

ii) **"Branch"** means specialization or discipline of programme like M.Tech. in Structural Engineering, Food Biotechnology etc., M.Sc. in Physics, Chemistry, Actuarial Science, Biotechnology etc.

iii) **"Course"** means a theory / practical / laboratory integrated theory / mini project / seminar / internship / project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.

iv) **"Institution"** means B.S. Abdur Rahman Crescent Institute of Science and Technology.

v) **"Academic Council"** means the Academic Council, which is the apex body on all academic matters of this Institute.

vi) **"Dean (Academic Affairs)"** means the Dean (Academic Affairs) of the Institution who is responsible for the implementation of relevant rules and regulations for all the academic activities.

vii) **"Dean (Student Affairs**)" means the Dean (Students Affairs) of the Institution who is responsible for activities related to student welfare and discipline in the campus.

viii) **"Controller of Examinations"** means the Controller of Examinations of the Institution who is responsible for the conduct of examinations and declaration of results.

ix) **"Dean of the School"** means the Dean of the School of the department concerned.

x) **"Head of the Department"** means the Head of the Department concerned.

2.0 PROGRAMMES OFFERED AND ADMISSION REQUIREMENTS

2.1 Programmes Offered

The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	
M.Com.	
M.A.	

2.2 ADMISSION REQUIREMENTS

2.2.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination as specified in the clause 3.2 [Eligible entry qualifications for admission to programmes] of this Institution or any other University or authority accepted by this Institution.

2.2.2 The other conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by the Institution from time to time.

3.0 DURATION, ELIGIBILITY AND STRUCTURE OF THE PROGRAMME

3.1. The minimum and maximum period for completion of the programmes are given below:

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA	4	8
M.Sc.	4	8
M.Com.	4	8
M.A.	4	8

3.1.1 Each academic semester shall normally comprise of 90 working days. Semester end examinations shall follow within 10 days of the last Instructional day.

3.1.2 Medium of instruction, examinations and project report shall be in English.

3.2 ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO PROGRAMMES

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
1.	Aeronautical Engineering	M.Tech. (Avionics)	B.E. / B.Tech. in Aeronautical Engineering / Aerospace Engineering / Mechanical Engineering / Mechatronics / EEE / ECE / EIE / or Equivalent degree in relevant field.
2.	Civil Engineering	M.Tech. (Structural Engineering)	B.E. / B.Tech. in Civil Engineering / Structural Engineering or Equivalent degree in relevant field.
		M. Tech. (Construction Engineering and Project Management)	B.E. / B.Tech. in Civil Engineering / Structural Engineering / B.Arch. or Equivalent degree in relevant field.
3.	Mechanical Engineering	M.Tech. (CAD/CAM)	B.E. / B.Tech. in Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Polymer / Plastics / Marine Engineering or Equivalent degree in relevant field.
4.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engineering)	B.E. / B.Tech. in EEE / ECE / EIE / ICE / Electronics / Instrumentation Engineering or Equivalent degree in relevant field.
5.	Electronics and Communication Engineering	M.Tech. (VLSI and Embedded Systems)	B.E. / B.Tech. in ECE / EIE / ICE / EEE / IT or Equivalent degree in relevant field.
6.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
		M.Tech. (Artificial Intelligence and	B.E. / B.Tech. in CSE / IT / ECE / EEE / EIE / ICE / Electronics Engineering /

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
		Data Science)	MCA or Equivalent degree in relevant field.
7.	Information Technology	M.Tech. (Information Technology)	B.E. / B.Tech. in IT / CSE / ECE / EEE / EIE / ICE / Electronics Engineering / MCA or Equivalent degree in relevant field.
8.	Computer Applications	MCA	BCA / B.Sc. Computer Science / B.E. / B.Tech. / B.Sc. Mathematics, B.Sc. Physics / Chemistry / B.Com. / BBA / B.A. with Mathematics at graduation level or at 10 + 2level or equivalent degree in relevant field.
9.	Mathematics	M.Sc. (Actuarial Science)	Any under graduate degree with Mathematics / Statistics as one of the subjects of study at 10 + 2 level.
10.	Physics	M.Sc.(Physics)	B.Sc. in Physics / Applied Science / Electronics /Electronics Science / Electronics & Instrumentation or Equivalent degree in relevant field.
11.	Chemistry	M.Sc.(Chemistry)	B.Sc. in Chemistry / Applied Science or Equivalent degree in relevant field.
12.	Life Sciences	M.Sc. Biochemistry & Molecular Biology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Biotechnology	B.Sc. in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or Equivalent degree in relevant field.
		M.Sc. Microbiology	B.Sc.in Biotechnology / Biochemistry / Botany / Zoology / Microbiology / Molecular Biology / Genetics or

Sl. No.	Name of the Department	Programmes offered	Eligibility for Admission in M.Tech. / MCA / M.Sc. / M.Com. / MA Programmes
			Equivalent degree in relevant field.
		M.Tech. Biotechnology	B.Tech. / B.E. in Biotechnology or Equivalent degree in relevant field.
		M.Tech. Food Biotechnology	B.E. / B.Tech. in Biotechnology / Food Biotechnology / Chemical Engineering / Biochemical Engineering / Industrial Biotechnology or Equivalent degree in relevant field.
13.	Commerce	M.Com	B.Com. / BBA
14.	Arabic and Islamic Studies	M.A. Islamic Studies	B.A. in Islamic Studies / Arabic (or) Afzal-ul-Ulama (or) Any under graduate degree with Part 1 Arabic (or)Any under graduate degree with AalimSanad / Diploma / Certificate in Arabic or Islamic Studies.

3.3. STRUCTURE OF THE PROGRAMME

3.3.1 The PG. programmes consist of the following components as prescribed in the respective curriculum:

i. Core courses
ii. Elective courses
iii. Laboratory integrated theory courses
iv. Project work
v. Laboratory courses
vi. Open elective courses
vii. Seminar
viii. Mini Project
ix. Industry Internship
x. MOOC courses (NPTEL- Swayam, Coursera etc.)
xi. Value added courses

3.3.2 The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

3.3.3 For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

3.3.4 The curriculum of programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Range of credits
M.Tech.	76 - 80
MCA	86
M.Sc.	77 - 85
M.Com.	88
M.A.	72

3.3.5 Credits will be assigned to the courses for all programmes as given below:

- ❖ One credit for one lecture period per week or 15 periods of lecture per semester.
- ❖ One credit for one tutorial period per week or 15 periods per semester.
- ❖ One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester.
- ❖ One credit for 160 hours of industry internship per semester for all programmes (except M.Com.)
- ❖ Four credits for 160 hours of industry internship per semester for M.Com.

3.3.6 The number of credits the student shall enroll in a non-project semester and project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 32	18 to 26
MCA	9 to 32	18 to 26
M.Sc.	9 to 32	10 to 26
M.Com.	9 to 32	16 to 28
M.A.	9 to 32	NA

3.3.7 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

3.3.8 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

3.3.9 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, aliter to open electives, during the entire period of study, with approval of Head of the department offering the course and parent department.

3.4. ONLINE COURSES

3.4.1 Students are permitted to undergo department approved online courses under SWAYAM up to 40% of credits of courses in a semester excluding project semester (in case of M.Tech. M.Sc. & MCA programmes) with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

3.4.2 Students shall undergo project related online course on their own with the mentoring of the project supervisor.

3.5 PROJECT WORK

3.5.1 Project work shall be carried out by the student under the supervision of a faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research organization, with the approval of the Head of the Department/ Dean of School. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist / Competent authority from the organization and the student shall be instructed to meet the faculty periodically and to attend the review meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last instructional day of the semester in which project is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work and shall re-register in the subsequent semester.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD/ Dean of School as Class Advisor for the class throughout their period of study.

The class advisor shall be responsible for maintaining the academic, curricular and co-curricular records of students of the class throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling, the Head of the Department / Dean of School of the students shall attach a maximum of 20 students to a faculty member of the department who shall function as faculty advisor for the students throughout their period of study. Such faculty advisor shall guide the students in taking up the elective courses for registration and enrolment in every semester and also offer advice to the students on academic and related personal matters.

5.0 COURSE COMMITTEE

5.1 Each common theory / laboratory course offered to more than one group of students shall have a “Course Committee” comprising all the teachers handling the common course with one of them nominated as course coordinator. The nomination of the course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

6.0 CLASS COMMITTEE

6.1 A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted in every semester:

6.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department

ii) Faculty members of all courses of the semester
iii) All the students of the class
iv) Faculty advisor and class advisor
v) Head of the Department – Ex officio member

6.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

6.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabi of courses.

6.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

7.0 REGISTRATION AND ENROLLMENT

7.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees. For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

7.2 Change of a Course

A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.3 Withdrawal from a Course

A student can withdraw from an enrolled course at any time before the first continuous assessment test for genuine reasons, with the approval of the

Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.4 A student can enroll for a maximum of 32 credits during a semester including Redo / Predo courses.

8.0 BREAK OF STUDY FROM PROGRAMME

8.1 A student may be allowed / enforced to take a break of study for two semesters from the programme with the approval of Dean (Academic Affairs) for the following reasons:

8.1.1 Medical or other valid grounds

8.1.2 Award of 'I' grade in all the courses in a semester due to lack of attendance

8.1.3 Debarred due to any act of indiscipline

8.2 The total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

8.3 A student who has availed a break of study in the current semester (odd/even) can rejoin only in the subsequent corresponding (odd/even) semester in the next academic year on approval from the Dean (Academic affairs).

8.4 During the break of study, the student shall not be allowed to attend any regular classes or participate in any activities of the Institution. However, he / she shall be permitted to enroll for the 'I' grade courses and appear for the arrear examinations.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT WORK

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	Minimum no. of credits to be earned to enroll for project semester
M.Tech.	18
MCA	22
M.Sc.	18
M.Com	NA
M.A.	NA

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 ATTENDANCE REQUIREMENT AND SEMESTER / COURSE REPETITION

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% to become eligible to appear for the semester end examination in that course, failing which the student shall be awarded “I” grade in that course.

10.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in the concerned course to the class advisor. The class advisor shall consolidate and furnish the list of students who have earned less than 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of the School. Thereupon, the Dean (Academic Affairs) shall officially notify the names of such students prevented from writing the semester end examination in each course.

10.3 If a student secures attendance between 65% and less than 75% in any course in a semester, due to medical reasons (hospitalization / accident / specific illness) or due to participation in the institution approved events, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examination of that course. In all such cases, the students shall submit the required documents immediately after joining the classes to the class advisor, which shall be approved by the Head of the Department / Dean of the School. The Vice Chancellor, based on the recommendation of the Dean (Academic Affairs) may approve the condonation of attendance.

10.4 A student who has obtained an “I” grade in all the courses in a semester is not permitted to move to the next higher semester. Such students shall repeat all the courses of the semester in the subsequent academic year. However, he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

10.5 The student awarded “I” grade, shall enroll and repeat the course when it is offered next. In case of “I” grade in an elective course either the same elective

course may be repeated or a new elective course may be taken with the approval of the Head of the Department / Dean of the School.

10.6 A student who is awarded "U" grade in a course shall have the option to either write the semester end arrear examination at the end of the subsequent semesters, or to redo the course when the course is offered by the department. Marks scored in the continuous assessment in the redo course shall be considered for grading along with the marks scored in the semester end (redo) examination. If any student obtains "U" grade in the redo course, the marks scored in the continuous assessment test (redo) for that course shall be considered as internal mark for further appearance of arrear examination.

10.7 If a student with "U" grade, who prefers to redo any particular course, fails to earn the minimum 75% attendance while doing that course, then he / she is not permitted to write the semester end examination and his / her earlier "U" grade and continuous assessment marks shall continue.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester without affecting the regular semester classes, whenever such courses are offered by the department concerned, based on the availability of faculty members, and subject to a specified minimum number of students registering for each of such courses.

11.2 The number of contact hours and the assessment procedure for any redo course shall be the same as regular courses, except there is no provision for any substitute examination and withdrawal from a redo course.

12.0 ASSESSMENT PROCEDURE AND PERCENTAGE WEIGHTAGE OF MARKS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightageof Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Theory Course

Appearing for semester end theory examination for each course is mandatory and a student shall secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

12.3 Laboratory Course

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However, a student shall have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.4 Laboratory Integrated Theory Courses

For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of theory components shall have a total of three assessments with two continuous assessments carrying 25% weightage each and semester end examination carrying 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination. The evaluation of practical components shall be through continuous assessment.

12.5 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.6 Industry Internship

In the case of industry internship, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research / academic organisation. The weightage of marks for industry internship report and viva voce examination shall be 60% and 40% respectively.

12.7 Project Work

In the case of project work, a committee of faculty members constituted by the Head of the Department / Dean of the School will carry out three periodic reviews. Based on the project report submitted by the students, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by the Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the viva voce examination.

12.8 The assessment of seminar course including its component and its weightage shall be decided by a committee of faculty members constituted by the Head of the Department. This committee shall ensure the conduct of assessment of components and award marks accordingly.

12.9 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be used for grading along with the marks scored in the arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination and the internal assessment marks secured during the course of study shall become invalid.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end examination for theory component. There shall be no arrear or improvement examination for lab components.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However, there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However, the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 SUPPLEMENTARY EXAMINATION

14.1 Final Year students can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise, students with less credit can also apply for supplementary examination for a maximum of three courses to enable them

to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semesters.

15. PASSING, DECLARATION OF RESULTS AND GRADE SHEET

15.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall preferably meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
I	0

"I" denotes inadequate attendance and hence prevented from appearing for semester end examination

"U" denotes unsuccessful performance in the course.

15.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

15.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department/Dean of School and it shall be declared by the Controller of Examinations.

15.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fees to the Controller of Examinations. Subsequently the Head of the Department/ Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as convener, the faculty member of the

course and a senior faculty member knowledgeable in that course as members. The committee shall meet within a week to re-evaluate the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

15.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i}$$

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

"I" grade is excluded for calculating GPA.

"U" and**"I"** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks is as follows:

Percentage Equivalent of Marks = CGPA X 10

15.6 After successful completion of the programme, the Degree shall be awarded upon fulfillment of curriculum requirements and classification based on CGPA as follows:

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the minimum prescribed period.
First Class	6.50 and above and completing the programme within a minimum prescribed period plus two semesters.

Second Class	Others

15.6.1 Eligibility for First Class with Distinction

- A student should not have obtained 'U' or 'I' grade in any course during his/her study
- A student should have completed the PG programme within the minimum prescribed period of study (except clause 8.1.1)

15.6.2 Eligibility for First Class

A student should have passed the examination in all the courses not more than two semesters beyond the minimum prescribed period of study (except clause 8.1.1)

15.6.3 The students who do not satisfy clause 15.6.1 and clause 15.6.2 shall be classified as second class.

15.6.4 The CGPA shall be rounded to two decimal places for the purpose of classification. The CGPA shall be considered up to three decimal places for the purpose of comparison of performance of students and ranking.

16.0 DISCIPLINE

16.1 Every student is expected to observe discipline and decorum both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

16.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

17.0 ELIGIBILITY FOR THE AWARD OF THE MASTER'S DEGREE

17.1 A student shall be declared to be eligible for the award of the Master's Degree, if he/she has:

i. Successfully acquired the required credits as specified in the curriculum corresponding to his/her programme within the stipulated time.
ii. No disciplinary action is pending against him/her.
iii. Enrolled and completed at least one value added course.
iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

17.2 The award of the degree must have been approved by the Institute.

18.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY
M.TECH. POWER SYSTEMS ENGINEERING
CURRICULUM & SYLLABUS, REGULATIONS 2022

SEMESTER I

Sl. No.	Course Code	Course Title	L	T	P	C
1	MAE 6184	Probability and Matrix Theory	3	1	0	4
2	EEE 6101	System Theory	3	0	0	3
3	EEE 6102	Advanced Power System Analysis	3	0	2	4
4	EEE 6103	Flexible AC Transmission System	3	0	0	3
5	EEE 6104	Power System Protection	3	0	2	4
6		Professional ElectiveCourse				3
7	ENE 6181	English for Career Development	1	1	0	2
		Credits				**23**

SEMESTER II

Sl. No.	Course Code	Course Title	L	T	P	C
1	GEE 6201	Research Methodology and IPR	2	0	0	2
2	EEE 6211	Advanced Power System Operation and Control	3	0	0	3
3	EEE 6212	Power System Dynamics	3	0	2	4
4		Professional Elective Courses				9
		Credits				**18**

SEMESTER III

Sl. No.	Course Code	Course Title	L	T	P	C
1		Open Elective	3	0	0	3
2		Professional Elective Courses###				6
2	EEE6215	Industrial Internship #				2
3	EEE7101	Project Phase I **	0	0	12	6**
4		MOOC (related to project)				-
		Credits				**11**

SEMESTER IV

Sl. No.	Course Code	Course Title	L	T	P	C
1	EEE 7101	Project Phase II**	0	0	36	**18****
		Credits				**6**+18 = 24**

Overall Total Credits – 76

** Credits for project work phase I in III semester to be accounted along with project work phase II in IV semester

Internship has to be carried out at the end of second semester during summer vacation

PROFESSIONAL ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C	Semester
1.	EEEY 001	Restructured Power Systems	3	0	0	3	II,III
2.	EEEY 002	EHV Power Transmission	3	0	0	3	I, II,III
3.	EEEY 003	Power Quality	3	0	0	3	I, II,III
4.	EEEY 004	Power System Planning and Reliability	3	0	0	3	II,III
5.	EEEY 005	Advanced Digital Signal Processing	3	0	0	3	II,III
6.	EEEY 006	Industrial Power System Analysis and Design	3	0	0	3	II,III
7.	EEEY 007	High Voltage Direct Current Transmission	3	0	0	3	I, II,III
8.	EEEY 008	Wind Energy Conversion Systems	3	0	0	3	I, II,III
9.	EEEY 009	Power Distribution Systems	3	0	0	3	I, II,III
10.	EEEY 010	Electrical Transients in Power Systems	3	0	0	3	I, II,III
11.	EEEY 011	Smart Power Grid	3	0	0	3	I, II,III
12.	EEEY 012	Distributed Generation and Micro-grid	3	0	0	3	I, II,III
13.	EEEY 013	State Estimation and Contingency Analysis in Smart-grid	3	0	0	3	II,III
14.	EEEY 014	Power Electronics Applications to Power Systems	3	0	0	3	I, II,III
15.	EEEY 015	Special Electrical Machines and Controllers	3	0	0	3	I, II,III
16.	EEEY 016	Solar and Energy Storage Systems	3	0	0	3	I, II,III
17.	EEEY 017	Fundamentals of Grid Connected Photo Voltaic Power Electronic Converter Design	3	0	0	3	I, II,III
18.	EEEY 018	Advanced Power Semiconductor Devices	3	0	0	3	I, II,III
19.	EEEY 019	Analysis of Power converters	3	0	0	3	I, II,III
20.	EEEY 020	Solid State AC & DC Drives	3	0	0	3	I, II,III

Sl. No.	Course Code	Course Title	L	T	P	C	Semester
21.	EEEY 021	Energy Auditing	2	0	0	2	I, II,III
22.	EEEY 022	Wide Area Measurement Systems	2	0	0	2	II,III
23.	EEEY 023	Power System Simulation Software	0	0	2	1	I, II,III
24.	EEEY 024	Simulation of Power Electronic Circuits	0	0	2	1	I, II,III
25.	EEEY 025	Electric Vehicles	3	0	0	3	II,III

LIST OF OPEN ELECTIVE COURSES – III SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	C	Offering Department / School
1.	OEEY 701	Analytical Techniques	3	0	0	3	Chemistry
2.	OEEY 702	Artificial Intelligence and IoT	3	0	0	3	CSE
3.	OEEY 703	Biomaterials	3	0	0	3	Physics
4.	OEEY 704	Biomedical Instrumentation	3	0	0	3	Physics
5.	OEEY 705	Biophotonics	3	0	0	3	Physics
6.	OEEY 706	Data Science and Machine Learning	3	0	0	3	IT
7.	OEEY 707	Electric Vehicle and Battery Storage Technology	3	0	0	3	EEE
8.	OEEY 708	Green Building and Energy Management	3	0	0	3	Civil Engineering
9.	OEEY 709	Industry 4.0 and Applications	3	0	0	3	ECE
10.	OEEY 710	Nanotechnology and Catalysis	3	0	0	3	Chemistry
11.	OEEY 711	Project Management	3	0	0	3	Mechanical
12.	OEEY 712	Real Time Embedded Systems	3	0	0	3	ECE
13.	OEEY 713	Robotic Technology	3	0	0	3	Mechanical
14.	OEEY 714	Soft Computing Techniques	3	0	0	3	EEE
15.	OEEY 715	Structural Interpretation of Materials	3	0	0	3	Chemistry

SEMESTER I

MAE 6184	PROBABILITY AND MATRIX THEORY	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The aim of this course is to impart the

- knowledge of the theory of probability and random variables.
- techniques to carry out probability calculations and identify probability distributions.
- knowledge of the multidimensional random variables.
- familiarizing with the advanced matrix theory concepts.
- importance of variational problems.

PREREQUISITE:

1. Basic concepts of probability, Mutually exclusive events and Independent events.
2. To know to find eigenvalues and eigenvectors of a square symmetric matrix.

MODULE I PROBABILITY AND RANDOM VARIABLE 9+3

Axioms of probability – Addition and Multiplication theorem – conditional probability –Total Probability – Baye's theorem - Random variable – Probability mass function – Probability density functions – Properties – Expectation - Moments – Moments generating functions and their properties.

MODULE II STANDARD DISTRIBUTIONS 9+3

Binomial, Poisson, Geometric, Negative Binomial, Uniform, Exponential, Gamma, weibull and Normal distributions.

MODULE III MULTIDIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Regression - Partial, Multiple correlations and regressions.

MODULE IV ADVANCED MATRIX THEORY 9+3

Matrix norms – singular value decomposition – QR algorithm – pseudo inverse – least square approximations.

MODULE V CALCULUS OF VARIATIONS 9+3

Variation and its properties – Euler's equation – functional dependent on first and higher order derivatives – functional dependent on functions of several independent variables – variational problems with moving boundaries – isoperimetric problems.

L- 45; T-15; TOTAL HOURS - 60

TEXT BOOKS:

1. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", Fifth Edition, Elesvier 2016.
2. Richard A. Johnson, "Probability and Statistics for Engineers", 8th Edition, Pearson Education, 2017.
3. T. Veerarajan, "Probability, Statistics and Random Processes", 3rd edition, Tata McGraw-Hill Publishing Company Limited, 2008.
4. Lewis D W, "Matrix Theory", Allied Publishers, Chennai 1995.
5. A. S. Gupta, "Calculus of variations with applications", PHI Pvt. Ltd. New Delhi 2011.

REFERENCES:

1. H.Cramer, "Random Variables and Probability Distributions", Cambridge University Press, 2004.
2. S.C.Gupta and V.K.Kapoor, "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand and Sons, 2014.
3. Roger A. Horn, Charles R Johnson , "Matrix Analysis", Cambridge University Press, 2nd edition, 2012.
4. Elsgolts, "Differential Equations and Calculus of Variations", University Press of the Pacific, 2003.

COURSE OUTCOMES:

On completion of the course, students will be able to

- do basic problems on probability.
- solve the probability problems using appropriate distributions.
- derive the probability mass / density function of a random variable and multiple correlations and regressions.

- find eigenvalues and eigenvectors of a higher order matrix.
- solve problems of calculus of variations by direct method and using Euler's formulae.

Board of Studies (BoS) :
23rd BOS of ECE held on 13.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO1	PSO2	PSO3
CO1	H	H	H	H	L	L	L	M	M	M	M	M	H	M	L
CO2	H	H	H	H	L	L	L	M	M	M	M	M	H	M	L
CO3	H	H	H	H	L	L	L	M	M	M	M	M	H	M	L
CO4	H	H	H	H	L	L	L	M	M	M	M	M	H	M	L
CO5	H	H	H	H	L	L	L	M	M	M	M	M	H	M	L

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4 : Quality Education Statement:

SDG 9: Industry, Innovation and Infrastructure.

EEE 6101	SYSTEM THEORY	L	T	P	C
SDG: 8, 12		3	0	0	3

COURSE OBJECTIVES:

COB1: To acquire knowledge on state-space approach, state feedback controllers and observers for different processes.

COB2: To study the properties of linear systems such as Controllability and Observability.

COB3: To gain knowledge on stability analysis of multivariable processes.

COB4: To understand nonlinear systems and its linearization methods.

COB5: To learn the stability of Linear and Non-Linear Systems.

MODULE I STATE SPACE APPROACH 9

Introduction to State Space Approach - System representation in state variable form – State transition matrix and its properties – Methods of computing the state transition matrix – System modes – Role of Eigen values and Eigen vectors.

MODULE II STATE FEEDBACK CONTROL AND STATE ESTIMATOR 9

Introduction – Controllable and Observable Companion Forms – SISO and MIMO Systems – The Effect of State Feedback on Controllability and Observability – Pole Placement by State Feedback for both SISO and MIMO Systems – Full Order and Reduced Order Observers.

MODULE III STABILITY FOR LINEAR SYSTEMS 9

Introduction – Equilibrium points – Stability in the sense of Lyapunov - BIBO Stability – Stability of LTI systems – The direct method of Lyapunov and the Linear continuous time autonomous systems – Popov Stability Criterion.

MODULE IV NON-LINEAR SYSTEMS 9

Types of Non-Linearity – Typical Examples – Phase plane analysis (analytical and graphical methods) – Limit cycles – Equivalent Linearization.

Describing Function Analysis for Non-Linear Systems, Describing Functions for different non-linear elements- backlash, dead zone, saturation and hysteresis.

MODULE V STABILITY FOR NON-LINEAR SYSTEMS 9

Equilibrium stability of nonlinear continuous time autonomous systems – Finding Lyapunov functions for nonlinear continuous time autonomous systems – Krasovskii and variable gradient method.

L - 45; TOTAL HOURS - 45

TEXT BOOK:

1. M.Gopal, “Modern Control System Theory”, New Age International, 2005.

REFERENCES:

1. K.Ogata, “Modern Control Engineering”, Prentice Hall of India, 2002.
2. John .S.Bay, “Fundamentals of Linear State Space Systems”, Tata McGraw– Hill, 1999.
3. Z.Bubnicki, “Modern Control Theory”, Springer, 2005.

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

CO1: implement state space approach for the given process.

CO2:design state feedback controller and observers.

CO3: perform stability analyses of the system using conventional mathematical approach.

CO4: analyze complex systems using mathematical models.

CO5: analyze the stability of Linear Systems using Lyapnov, Popov Stability Criterions and the stability of Non-Linear Systems using novel techniques.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	M	L	M	H	H	L	L	H	M	L	H
CO2	H	H	M	M	H	H	H	H	M	M	H	H	H	H
CO3	H	H	H	H	M	M	L	L	M	L	M	H	H	H
CO4	H	H	M	H	L	H	M	L	L	H	H	H	H	H
CO5	H	M	L	H	H	M	L	M	M	M	H	H	H	L

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 12: Responsible consumption and production.

Statement: Application of knowledge obtained from this course will lead to reasonable consumption and production.

		L	T	P	C
EEE 6102	**ADVANCED POWER SYSTEM ANALYSIS**				
SDG: 8, 9		**3**	**0**	**2**	**4**

COURSE OBJECTIVES:

COB1: To introduce efficient numerical techniques applied to sparse matrix for planning and operation of power system.

COB 2: To gain in-depth knowledge in power flow analysis for single and multi-area system.

COB 3: To study optimal Power Flow solutions for single and multi-area system.

COB 4: To study short circuit analysis and to design the circuit breaker and protection system.

COB 5: To learn the effects of multiple contingencies in power system.

MODULE I SPARSE MATRICES IN POWER SYSTEMS 9+6

Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays - Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

Practical Exercise: Developing a program for storing matrices using sparse matrix techniques and for implementing optimal ordering schemes.

MODULE II POWER FLOW ANALYSIS 9+6

Power flow equation in real and polar forms; Review of Newton's method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment; DC Power Flow; Net Interchange power control in Multi-area power flow analysis.

Practical Exercises: Development of load flow analysis program by Newton-Raphson and FDPF methods including adjustment of PV buses.

MODULE III OPTIMAL POWER FLOW 9+6

Problem statement; Solution of Optimal Power Flow (OPF) - The gradient method, Newton's method, Linear Sensitivity Analysis; LP methods - With real power variables only - LP method with AC power flow variables and detailed cost functions; Generation outage and line outage - Sensitivity factors - Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs. DC Optimal Power Flow (DCOPF).

Practical Exercise: Development of DC optimal power flow program.

MODULE IV SHORT CIRCUIT ANALYSIS 9+6

Fault calculations using sequence networks for different types of faults. -Bus impedance matrix (ZBUS) construction using Building Algorithm for lines with mutual coupling; - Simple numerical problems. - Computer method for fault analysis using ZBUS and sequence components. - Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase domain using Thevenin's equivalent and ZBUS matrix for different faults.

Practical Exercise: Development of a program for Z bus building algorithm and symmetrical and unsymmetrical short circuit analysis using Z bus.

MODULE V TRANSIENT STABILITY ANALYSIS 9+6

Power angle curve – Review of numerical integration methods: Euler and Fourth Order Runge Kutta methods, Numerical stability and implicit methods, Equal area criterion to test the transient stability of simple power systems – Calculation of critical clearing angle and clearing time – Further applications of the equal area criterion and its limitations

Practical Exercise: Transient stability analysis of multi-machine power system using appropriate software.

L - 45; P - 30; TOTAL HOURS - 75

TEXT BOOK:

1. .W Stagg, A.H El. Abiad, “Computer Methods in Power System Analysis”, McGraw Hill, 1968.

REFERENCES:

1. P.Kundur, “Power System Stability and Control”, McGraw Hill, 1994.
2. A.J.Wood and B.F.Wollenberg, “Power Generation Operation and Control”, John Wiley and sons, New York, 1996.
3. W.F.Tinney and W.S.Meyer, “Solution of Large Sparse System by Ordered Triangular Factorization”, IEEE Trans. on Automatic Control, Vol:18, pp:333-346, Aug 1973.
4. K.Zollenkopf, “Bi-Factorization: Basic Computational Algorithm and Programming Techniques; pp: 75-96; Book on “Large Sparse Set of Linear Systems” Editor: J.K.Rerd, Academic Press, 1971.
5. Mariesa L. Crow, “Computational Methods for Electric Power Systems’, Second Edition CRC Press, 2009.
6. John Grainger, William Stevenson Jr., ‘’Power System Analysis’’ First Edition, McGraw-Hill, 1994
7. L.P. Singh, “Advanced Power System: Analysis and Dynamics”, Sixth Revised Edition, New Age International Pvt. Ltd., 2014.

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1: apply relevant solution techniques for sparse matrices in power system analysis.

CO2:perform load flow study and interpret the result effectively for power system operational problems.

CO3: simulate optimal settings for power system operation by performing optimal power flow analysis

CO4:perform short circuit analyze and interpret the result for designing the circuit breaker and protection system in long term planning problem.

CO5:assess the transient stability of power system.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	M	L	M	H	H	L	L	H	M	L	H
CO2	H	H	M	M	H	H	H	H	M	M	H	H	H	H
CO3	H	H	H	H	M	M	L	L	M	L	M	H	H	H
CO4	H	H	M	H	L	H	M	L	L	H	H	H	H	H
CO5	H	M	L	H	H	M	L	M	M	M	H	H	H	L

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 12: Responsible consumption and production.

Statement: Application of knowledge obtained from this course will lead to reasonable consumption and production.

EEE 6103	FLEXIBLE AC TRANSMISSION SYSTEM	L	T	P	C
SDG: 3, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the need of reactive power compensation in transmission system.

COB2: To study the role of SVC in transmission system.

COB3: To understand the basic concepts of TCSC, GCSC and its applications.

COB4: To learn the characteristics, applications and modeling of series and shunt FACTS controllers

COB5: To analyze the interaction of different FACTS controller and study control coordination

MODULE I INTRODUCTION 9

Introduction to FACTS- Types of FACTS controllers- FACTS vs. HVDC- Benefits of FACTS- Performance Equations and Parameters of Transmission Lines- Transfer of Active and Reactive Power over a Transmission Line, Uncompensated Transmission lines- Need for Compensation- Functions of compensation.

MODULE II STATIC VAR COMPENSATOR (SVC) 9

Types of SVC - Voltage control by SVC - Modeling of SVC for load flow analysis and stability studies - Design of SVC to regulate the midpoint voltage of a SMIB system - Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

MODULE III THYRISTOR AND GTO THYRISTOR CONTROLLED SERIES CAPACITORS 9

Principle of Controlled Series Compensation – Operation of TCSC and GCSC – Analysis of TCSC - Modeling of TCSC for Load Flow and Stability studies – Applications of TCSC – Applications of TCSC and GCSC.

MODULE IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC) - Operation of STATCOM and SSSC - Power flow control with STATCOM and SSSC- Modeling of STATCOM and SSSC for power flow and transient stability studies – operation of Unified and Interline power flow controllers (UPFC and IPFC)- Modeling of UPFC for load flow and transient stability studies -

Applications.

MODULE V CONTROLLERS AND THEIR CO-ORDINATION 9

FACTS Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination - control coordination using genetic algorithms.

L - 45; TOTAL HOURS - 45

TEXT BOOKS:

1. R.Mohan Mathur, Rajiv K.Varma, “Thyristor - Based FACTS Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc., 2002.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi- 110 006,1999.

REFERENCES:

1. K.R.Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008 .
2. A.T.John, “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE)”, Wiley IEEE Press,1999.
3. V.K.Sood, “HVDC and FACTS controllers - Applications of Static Converters in Power System”, Kluwer Academic Publishers, 2004.

COURSE OUTCOMES:

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

CO1:identify the need for compensation in transmission system and utility using conventional and FACTS devices

CO2: apply SVC for voltage regulation and to implement SVC for transient stability enhancement and to damp power oscillations

CO3: model and implement TCSC and GCSC for increasing the power transfer capability

CO4: model and implement converter-based series and shunt FACTS controllers for the enhancement of power system performance

CO5:analyze the interactions amongst various FACTS controllers.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**H**	**H**	**H**	**H**	**H**	**L**	**L**	M	M	M	**L**	**H**	**H**	M
CO2	**H**	**H**	**H**	**H**	**H**	**L**	**L**	M	M	M	**L**	**H**	**H**	M
CO3	**H**	**H**	**H**	**H**	**H**	**L**	**L**	M	M	M	**L**	**H**	**H**	M
CO4	**H**	**H**	**H**	**H**	**H**	**L**	**L**	M	M	M	**L**	**H**	**H**	M
CO5	**H**	**H**	**H**	**H**	**H**	**L**	**L**	M	M	M	**L**	**H**	**H**	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and well-being.

Statement: Understanding of the fundamentals transmission system and FACTS devices can help in designing systems to promote good health and well-being.

SDG 8: Descent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in electrical engineering filed.

EEE 6104	POWER SYSTEM PROTECTION	L	T	P	C
SDG: 3, 8		3	0	2	4

COURSE OBJECTIVES:

COB1: To gain knowledge on fault characteristics of individual Power System elements.

COB2: To study various schemes of protection employed in Generator and Transformer protection**.**

COB3: To learn the Protection of bus bars.

COB4: To gain knowledge on over current protective schemes and relays used for protection of transmission lines.

COB5: To familiarize centralised numerical protection scheme.

MODULE I GENERATOR PROTECTION 7+6

Introduction to Equipment Protection - Electrical circuit of the generator -Various faults and abnormal operating conditions - Rotor faults - Abnormal operating conditions; Numerical examples for typical generator protection schemes - IEEE/IEC standards.

Practical Exercise: Study of generator protection algorithms and computation of relay settings using appropriate software

MODULE II TRANSFORMER PROTECTION 10+6

Types of transformers - Phasor diagram for a three Phase transformer -Equivalent circuit of transformer - Mechanical protection devices - Buchholz relay, pressure release devices , alarms, etc - Types of faults in transformers - Over current protection - Percentage Differential Protection of Transformers - Inrush phenomenon - High resistance Ground Faults in Transformers – Inter turn faults in transformers - Incipient faults in transformers - Phenomenon of over fluxing in transformers - Transformer protection application chart - Numerical examples for typical transformer protection schemes - IEEE/IEC standards.

Practical Exercise: Computation of transformer differential relay settings and simulation of different transformer faults using appropriate software.

MODULE III BUSBAR PROTECTION 10+6

Introduction – Differential protection of busbars - External and internal fault - Actual behaviours of a protective CT - Circuit model of a saturated CT - External fault with one CT saturated: the need for high impedance Busbar protection –Supervisory relay - Protection of three Phase busbars - Numerical example on design of high

impedance bus bar differential scheme - IEEE/IEC standards.

Practical Exercise: Computation of relay settings for bus bar differential protection scheme and partial bus bar differential protection scheme using appropriate software.

MODULE IV OVER CURRENT ANDDISTANCEPROTECTION 10+6

Time - Current characteristics - Current setting - Time setting - Over current protective schemes - Reverse power or directional relay - Earth fault and phase fault protection - Combined Earth fault and phase fault protection scheme - Phase fault protective scheme - Directional earth fault relays-Drawbacks of over Current protection –distance protection–impedance relay – Reactance relay – Mho relay - comparison between distances relays-Need for carrier aided protection — Carrier aided distance schemes – Phase comparison relaying - IEEE/IEC standards.

Practical Exercise: Study and simulation of over current protection schemes for earth and phase faults using appropriate software.

MODULE V NUMERICAL PROTECTION 8+6

Introduction – Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave - Digital filtering - Numerical over Current protection – Numerical transformer differential protection - Numerical distance protection of transmission line - Architecture of modern distributed and centralized protection schemes - IEEE/IEC standards.

Practical Exercise: Creation and simulation of a numerical over current protection scheme using appropriate software.

L - 45; P – 30; TOTAL HOURS - 75

TEXT BOOKS:

1. Y.G. Paithankar and S.R Bhide, “Fundamentals of Power System Protection”, Prentice-Hall of India, 2010
2. Badri Ram and D.N. Vishwakarma, “Power System Protection and Switchgear”, Tata McGraw- Hill Publishing Company, 2011.

REFERENCES:

1. BhaveshBhalja, R. P. Maheswari and NileshGhothani, “Protection and Switchgear,” Oxford University press, 2011.
2. J. Lewis Blackburn and Thomas J. Domin “Protection Relaying: Principles and Applications”, CRC press, 2014.

COURSE OUTCOMES:

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

CO1: identify and analyse the fault characteristics of individual power system elements.

CO2: select various schemes employed in Generator and Transformer protection.

CO3: design busbar differential protection scheme.

CO4: design over current, distance and carrier protection for transmission lines.

CO5: design numerical protection scheme.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M	M	H	L	H	L	L	L	L	L	H	M
CO2	H	L	H	M	L	M	M	L	L	L	M	L	H	H
CO3	M	H	M	L	M	L	L	L	L	L	L	L	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	M	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and wellbeing.

Statement: Understanding the fundamentals of this course can help in designing systems to promote good health and well-being.

SDG 8: Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Decent Work and Economic Growth is supported via an increasing supply of competent engineers who will help solve the challenges of the future in all areas of everyday life. Most of the engineers graduated from Electrical Engineering stay in the area and support the economic growth and viability of local companies.

ENE 6181	**ENGLISH FOR CAREER DEVELOPMENT**	**L**	**T**	**P**	**C**
SDG: 4 and 8		**1**	**1**	**0**	**2**

COURSE OBJECTIVES:

COB1: To enable students to learn about the job search, application, and interview process

COB2: To give them an opportunity to explore their global career path, build vocabulary and improve language skills to achieve professional goals

COB3: To produce a professional-looking resume

COB5: To understand networking and interview skills

COB6: To understand the key skills and behaviors required tofacilitate a group discussion

MODULE I ENTERING THE JOB MARKET 3+2

Introduction to the Career Development -Job Search Overview-Identifying Your Interests and Skills

Language Focus: Vocabulary and Word Forms Related to Jobs-Choosing the Job that's the Best Fit

Language Focus: Verb Tenses (Present vs. Present Progressive) Understanding Job Descriptions: Reading a Job Advertisement

Language Focus: Phrases to Compare Similarities

Online Learning Opportunities to Extend Your Skills

MODULE II RESUMES 3+2

What is a resume? Why do you need one?

Parts of a Resume-Writing a Resume, Part 1: Name and Contact Information

Listening: Connecting Employers with Job Seekers in Today's Economy

Language Focus: Key Words

Writing a Resume, Part 2: Headline and Summary

Writing a Resume, Part 3: Work Experience

Writing a Resume, Part 4: Education

Language Focus: Action Verbs

Writing a Resume, Part 5: Complete your Resume

MODULE III WRITING A COVER LETTER 3+2

What is a Cover Letter?

Professional Writing: Letter Format

Cover Letter: Paragraph 1- Introducing Yourself

Cover Letter: Paragraph 2- Highlighting Your Skills in the Cover letter

Cover Letter: Paragraph 3- Closing
Language Focus – Present Perfect vs. Past Tense
Professional Writing: Level of Formality
Language Focus: Using Modal Verbs to Write politely
Writing a Cover Letter for a Specific Job

MODULE IV INTERVIEWING FOR A JOB 3+5

Overview of the Job Interview: Answering Typical Interview Questions Language Focus: Asking for Clarification in an Interview-
Sample Interview: Do's and Don'ts Part 1
Sample Interview: Do's and Don'ts Part 2
Sample Video: Responding to an Interview Question

MODULE V GROUP DISCUSSION 3+4

Introduction to Group Discussion - Participating in group discussions – understanding group dynamics - brainstorming the topic - questioning and clarifying - GD strategies- activities to improve GD skills

L-15, T-15; TOTAL HOURS - 30

REFERENCES:

1. R. Byrne, D. *Teaching Oral Skill.* London: Longman. 1975.
2. Byrne, D.*Teaching Writing*, London: Longman. 1975.
3. Rani Asoka, DeviVimala. *English for Career development: ACourse in Functional English.* Orient Longman Pvt. Ltd., India,2004.
4. Anderson, K., Maclean, J. & Lynch, T. *Study speaking: A Course in Spoken English for Academic Purposes*. Cambridge University Press, UK, 2004.
5. Withrow, J., Brookes, G.& Cummings, M.C.*Inspired to write. Reading and Tasks to Develop Writing Skills*. Cambridge University Press, U.K., 2004.
6. Shinde, Maithry etal.*Life Skills & Personality Development*, Cambridge University Press India Pvt.Ltd, New Delhi
7. Fernandez, Agna *Generic Skills for Employability* .Cambridge University Press India Pvt.Ltd, New Delhi

COURSE OUTCOMES:

CO1: Identify the steps in the job search process

CO2: Describe themselves and their experiences in a résumé

CO3: Build their job-related vocabulary

CO4: Write a clear cover letter that tells employers why they are the right person for

the job

CO5: Take part in Group discussion confidently.

Board of Studies (BoS) :	**Academic Council:**
15thBoS of the Department of English held on 14.6.2022	19th Academic Council held on 29.09.2022

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Statement: This course ensures that the students acquire quality education and are also made eligible to obtain productive and decent employment.

SEMESTER II

ECE 6201	RESEARCH METHODOLOGY AND IPR	L	T	P	C
SDG: 4, 8, 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To apply a perspective on research

COB2: To analyze the research design, information retrieval and problem formulation techniques.

COB3: To select the appropriate statistical techniques for hypothesis construction and methods of data analysis and interpretation

COB4: To execute the effective communications of research findings and apply the ethics in research.

COB5: To describe the research findings as research reports, publications, copyrights Patenting and Intellectual Property Rights.

PREREQUISITES:

- Basics of core engineering, probability and statistics.
- Basics of flowchart and algorithm techniques.

MODULE I RESEARCH PROBLEM FORMULATION AND RESEARCH DESIGN **6**

Research - objectives – types - Research process, solving engineering problems- Identification of research topic - Formulation of research problem, literature survey and review. Research design - meaning and need - basic concepts - Different research designs, Experimental design - principle, Design of experimental setup, Mathematical modeling - Simulation, validation and experimentation.

MODULE II DATA COLLECTION, ANALYSIS AND INTERPRETATION OF DATA **8**

Sources of Data, Use of Internet in Research, Types of Data - Research Data Processing and analysis - Interpretation of results- Correlation with scientific facts - repeatability and reproducibility of results - Accuracy and precision –limitations, Application of Computer in Research- Spreadsheet tool-Basic principles of Statistical Computation. Importance of statistics in research - Concept of probability - Popular distributions - Sample design. Hypothesis testing, ANOVA, Design of experiments - Factorial designs - Orthogonal arrays.

MODULE III OPTIMIZATION TECHNIQUES 8

Use of optimization techniques - Traditional methods – Evolutionary Optimization Techniques. Multivariate analysis Techniques, Classifications, Characteristics, Applications - correlation and regression, Curve fitting.

MODULE IV INTELLECTUAL PROPERTY RIGHTS 8

The Research Report - Purpose of written report - Synopsis writing - preparing papers for International Journals, Software for paper formatting like LaTeX/MS Office, Reference Management Software, Software for detection of Plagiarism – Thesis writing, - Organization of contents - style of writing- graphs, charts and Presentation tool - Referencing, Oral presentation and defense - Ethics in research - Patenting, Intellectual Property Rights - Patents, Industrial Designs, Copyrights, Trade Marks, Geographical Indications-Validity of IPR, Method of Patenting, procedures, Patent Search.

L –30 ; TOTAL HOURS – 30

TEXT BOOKS:

1. Ganesan R., “Research Methodology for Engineers”, MJP Publishers, Chennai, 2011.
2. George E. Dieter., “Engineering Design”, McGraw Hill – International edition, 2020.
3. Kothari C.R., “Research Methodology” – Methods and Techniques, New Age International (P) Ltd, New Delhi, 2020.
4. Kalyanmoy Deb., “Genetic Algorithms for optimization”, Kangal report, No.2001002.
5. Rajkumar S. Adukia, “Handbook on Intellectual Property Rights in India”, TMH Publishers, 2020.
6. Prabhuddha Ganguli. ”Intellectual Property Rights”. 1st Edition, TMH Publishers, 2012.

REFERENCES:

1. Holeman, J.P., ”Experimental methods for Engineers, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2017.
2. Govt. of India, ”Intellectual Property Laws; Acts, Rules & Regulations”, Universal Law Publishing Co. Pvt. Ltd., New Delhi 2020.
3. R Radha Krishnan & S Balasubramanian, ”Intellectual Property Rights”. 1st Edition, Excel Books, 2012.
4. Derek Bosworth and Elizabeth Webster. ”The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2013.

COURSE OUTCOMES:

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

CO1: Formulate the research problem

CO2: Design and Analyze the research methodology

CO3: Apply statistical techniques for hypothesis construction

CO4: Analyze and interpret the data to construct and optimize the research hypothesis

CO5: Report the research findings as publications, copyright, trademarks and IPR

Board of Studies (BoS) :
23rd BOS of ECE held on 13.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	H	H	H	H	M	L	L	L	L	L	L	L	H	H	H
CO2	H	H	H	H	M	-	-	-	-	-	-	-	H	H	H
CO3	H	H	H	H	M	L	L	L	L	L	L	-	H	H	H
CO4	H	H	H	H	M	-	M	M	M	M	M	-	H	H	H
CO5	H	H	H	H	M	-	M	M	M	M	M	-	H	H	H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4: Analysis and design of core field design promotes engineering skills and quality education.

Statement: This course enables the student to analyze the existing technology for further solution and its qualitative measures in terms of societal requirements..

SDG 8: Development of new technologies with core field design provides sustainable economic growth and productive employment.

Statement: To apply the hybrid techniques and concepts for different applications provides sustainable economic growth and productive employment.

SDG 9: Creative and curiosity of core field design fosters innovation and sustainable industrialization.

Statement: This course plays major roles through innovative ideas in industry towards modern infrastructures and sustainability.

EEE 6211	ADVANCED POWER SYSTEM	L	T	P	C
SDG: 8, 9	OPERATION AND CONTROL	3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on the methods to estimate load forecasting.

COB 2: To learn unit commitment problem.

COB 3: To acquire knowledge on economic load dispatch.

COB 4: To understand the concepts of hydrothermal scheduling.

COB 5: To study the basics of AGC and the security of power systems.

MODULE I LOAD FORECASTING 9

Introduction – Estimation of Average and trend terms – Estimation of periodic components – Estimation of Stochastic components: Time series approach – Auto-Regressive Model, Auto-Regressive Moving – Average Models – Kalman Filtering Approach – On-line techniques for non-stationary load prediction.

MODULE II UNIT COMMITMENT 10

Constraints in unit commitment – Spinning reserve – Thermal unit constraints – Other constraints – Solution using Priority List method, Dynamic programming method - Forward DP approach Lagrangian relaxation method – adjusting lambda.

MODULE III GENERATION SCHEDULING 9

The Economic dispatch problem – Thermal system dispatching with network losses considered – The Lambda – iteration method – Gradient method of economic dispatch – Economic dispatch with Piecewise Linear cost functions – Transmission system effects – A two generator system – coordination equations – Incremental losses and penalty factors. Base point and participation factors.

MODULE IV HYDROTHERMAL CO-ORDINATION 10

Introduction- Hydroelectric plant models-Scheduling Problems-Short term hydro thermal scheduling problem-Gradient approach-Hydro units in series(Hydraulically coupled)-Pumped storage hydro scheduling with a iteration method – Pumped storage hydro scheduling by a gradient method-Dynamic programming solution to hydro thermal scheduling problem.

MODULE V CONTROL OF POWER SYSTEMS 7

Review of AGC -System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls

(Preventive, emergency and restorative) - Energy control center – SCADA system – Functions – monitoring, Data acquisition and controls – Energy management system.

L - 45;TOTAL HOURS - 45

TEXTBOOK:

1. Allen J.Wood and Bruce.F.Wollenberg, “Power Generation Operation and Control’, John Wiley & Sons, New York, 2014.

REFERENCES:

1. O.I.Elgerd, “Electric Energy System Theory - an Introduction”, - Tata McGraw Hill, New Delhi, 2017.
2. P.Kundur; “Power System Stability and Control”, EPRI Publications, California, 2006.
3. A.K.Mahalanabis, D.P.Kothari. andS.I.Ahson., “Computer Aided Power System Analysis and Control”, Tata McGraw Hill publishing Ltd, 1988.

COURSE OUTCOMES:

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

CO1: carry out load forecasting using different techniques.

CO2: performreal time unit commitment problem.

CO3: determine optimal generation scheduling with and without transmission loss

CO4: performAutomatic Generation Control and security of power systems

CO5: carry outHydro thermal co-ordination using different techniques.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	H	L	L	L	H	H	M	H	H	H
CO2	H	H	M	M	H	L	L	L	H	H	M	H	H	H
CO3	H	H	M	M	H	L	L	L	H	H	M	H	H	H
CO4	H	H	M	M	H	H	L	L	L	H	M	H	H	H
CO5	H	H	H	M	H	H	L	L	L	H	M	H	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic

Statement: The learners of this course can get decent work and earn financial benefits.

SDG 9: Industry, innovation and infrastructure

Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure. Engineering stay in the area and support the economic growth and viability of local companies.

EEE 6212	POWER SYSTEM DYNAMICS	L	T	P	C
SDG: 8, 9		3	0	2	4

COURSE OBJECTIVES:

COB1: To study the basic concepts of power system stability.

COB2: To gain knowledge on dynamic modeling of a synchronous machine in detail.

COB3: To learn the excitation and speed governing system under dynamic conditions.

COB4: To gain knowledge on fundamental concepts of small disturbance stability of dynamic systems.

COB5: To study voltage stability analysis.

MODULE I INTRODUCTION TO POWER SYSTEM STABILITY 6

Power system stability: Basic Concepts and Definitions - Classification of Power system Stability –Rotor angle stability-Voltage stability and Voltage collapse- mid-term and long- term stability-stability phenomena-Historical review of stability problem- case studies.

MODULE II SYNCHRONOUS MACHINE MODELLING 10+6

Schematic Diagram, Physical Description, Mathematical Description of a Synchronous Machine: Basic equations of a synchronous machine: stator circuit equations, dq0 Transformation: flux linkage and voltage equations for stator and rotor in dq0 coordinates, physical interpretation of dq0 transformation, Equivalent Circuits for direct and quadrature axes, Steady state Analysis: Voltage, current and flux-linkage relationships, Phasor representation, Rotor angle, Steady-state equivalent circuit, Computation of steady-state values, Equations of Motion: Swing Equation.

Practical Exercise: Development of program for steady-state analysis of a synchronous machine using appropriate software

MODULE III MODELLING OF EXCITATION AND SPEED GOVERNING SYSTEMS 10+12

Excitation System Requirements; Elements of an Excitation System; Types of Excitation System; Control and protective functions; IEEE (1992) block diagram for simulation of excitation systems. Turbine and Governing System Modeling, hydroelectric plant, classical transfer function of a hydraulic turbine (no derivation),

special characteristic of hydraulic turbine, electrical analogue of hydraulic turbine, Governor for Hydraulic Turbine: Requirement for a transient droop, Block diagram of governor with transient droop compensation, Steam turbine modeling: single reheat tandem compounded type.

Practical Exercise: Simulation of response of different excitation and speed governing (thermal and hydro) for a step input using appropriate software.

MODULE IV SMALL-SIGNAL STABILITY ANALYSIS WITHOUT CONTROLLERS 10+12

Rotor angle stability, State-space representation, Linearization, Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, Eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, block diagram representation with K-constants; expression for K-constants (no derivation), effect of field flux variation on system stability: analysis with numerical example - Enhancement Of Small Signal Stability and its countermeasures- case study.

Practical Exercise: Development of small signal stability program for multi machine power system using classical machine model using appropriate software.

MODULE V VOLTAGE STABILITY ANALYSIS 9+6

Voltage and frequency controllers - Limiting devices affecting voltage stability - Voltage-reactive power characteristics of synchronous generators - Capability curves - Effect of machine limitation on deliverable power - Load Aspects - Voltage dependence of loads - Load restoration dynamics- case study.

Practical Exercise: Examining the effect of various load models on voltage stability using appropriate software

L - 45;P - 30; TOTAL HOURS - 75

TEXTBOOK:

1. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2006**.**

REFERENCES:

1. P.M Anderson and A.A Fouad, “Power System Control and Stability”, Iowa State University Press, Ames, Iowa, 2003.
2. R. Ramanujam, “Power system dynamics, analysis and simulation”, Prentice Hall India Learning Pvt. Ltd., New Delhi, 2009

3. IEEE Committee Report, “Dynamic Models for Steam and Hydro Turbines in Power System Studies”, IEEE Trans., Vol.PAS-92, pp:1904-1915, November/ December, 1973. on Turbine- Governor Model.

COURSE OUTCOMES:

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

CO1: model the synchronous machine for stability analysis.

CO2: model excitation and speed governing system for stability analysis.

CO3: analyze the stability of a small multi-machine power system model using commercial software.

CO4: analyze the small signal stability of power systems.

CO5:investigate voltage stability of power system.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M	M	L	L	L	L	L	L	M	L	H	H
CO2	H	H	M	H	H	L	M	L	L	L	M	L	H	H
CO3	H	H	M	M	M	L	L	L	L	L	L	L	H	H
CO4	H	H	M	M	M	M	L	L	L	L	M	M	H	H
CO5	H	M	M	H	M	M	M	M	M	M	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 9: Build resilient Infrastructure, to support economic development and human well-being with a focus on affordable and equitable access for all.

Statement: The complete understanding of this course lead to sustainable industrialization and promote economic development.

SEMESTER III

EEE 6215	INDUSTRIAL INTERNSHIP	L	T	P	C
					2

* Minimum of 15 days.

** Industrial internship will be undertaken during first year summer vacation. One credit will be awarded in the 3rd semester for the completion of industrial internship.

COURSE OBJECTIVE:

- To expose the students to an industrial environment and make them industry ready.

COURSE DESCRIPTION:

1. To earn credits for this course, industrial training for a period of 15 days, in a single slot, is mandatory. The course has to be undertaken during the first year summer vacation and the credits will be awarded in the third semester.
2. If the student is not able to complete the internship during the first year summer vacation, he/she can complete the course in a single slot between 2th and 4th semester vacation.
3. For effective implementation of the course Industry Internship, a teaching faculty is appointed as the coordinator by the Head of the department.
4. The students will be allowed to undergo training only in reputed companies/research labs/design centres. The co-ordinator identifies the companies related to core engineering for internship during second semester. He/she assists the students in every process of getting into the companies as an intern.
5. To enable the students to focus on the internship, no two students are allowed to be in the same site.
6. Interacting with the respective industries, where the students do their internship, the Coordinator continuously monitors the performance of the students during the internship.
7. After completion of the internship, the students are required to submit a detailed report and present what they had learned through the internship, in the form of posters. The students should submit the industry certificate at the time of giving the presentation.
8. The performance of the student will be evaluated by the industry as well as the

University. Both the evaluations will be considered and aggregated to award the final grade. 50% weightage is given to the evaluation by the industry and remaining 50% weightage to the evaluation by the committee appointed by the Head of the Department.

9. The 50 % weightage of evaluation done at the department comprises of (a) 20/50 for viva-voce, (b) 20/50 for the Intern report and (c) 10 /50 for poster presentation.

COURSE OUTCOMES:

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

- Solve problems typically encountered by engineers in industry.
- Identify and address social, economic, and safety issues in an engineering problem and develop a solution that addresses this.
- Learn new concepts and apply them to the solution of engineering problems.
- Function effectively on a multidisciplinary team and interface effectively with other areas of the organization.
- Clearly communicate their ideas orally and in writing.
- Prepare for a lifelong productive career as an engineer.

		L	T	P	C
EEE 7101	**PROJECT WORK**				
	PHASE – I (SEMESTER III)	**0**	**0**	**12**	**6***
	PHASE – II (SEMESTER IV)	**0**	**0**	**36**	**6+18***

* Credits for Project work (Phase-I) of third semester will be accounted along with Project work (Phase-II) of fourth semester

COURSE OBJECTIVES:

- To enable a student to do an individual project work which may involve design, modeling, simulation and/or fabrication.
- To analyze a problem both theoretically and practically.
- To motivate the students to involve in research activities leading to innovative solutions for industrial and societal problems.

COURSE DESCRIPTION:

Project work shall be carried out by each and every individual student under the supervision of a faculty of this department. A student may however, in certain cases, be permitted to work for the project in association with other departments or in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and the faculty of the other department of the University or an Engineer / Scientist from the organization. The student shall meet the faculty periodically and attend the periodic reviews for evaluating the progress.

Project work will be carried out in two phases, Phase-I during the pre-final semester and Phase-2 during the final semester. Phase-I shall be pursued for a minimum of 12 periods per week and Phase – II in 36 periods per week. Credits for Phase I will be accounted along with Phase II in the final semester.

In each phase, there will be three reviews for continuous assessment and one final review and viva voce at the end of the semesters. The Project Report prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

COURSE OUTCOMES:

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

- Comprehend a problem thoroughly and provide an appropriate solution.
- Do a systematic literature survey.
- Derive a mathematical model for the system under study.

- Get proficiency over the software used for simulation and analysis.
- Present the findings of a research work in conferences and publish in journals.
- Identify and provide solution for the industrial and societal problems.

PROFESSIONAL ELECTIVES

EEEY 001	RESTRUCTURED POWER SYSTEMS	L	T	P	C
SDG: 8, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on restructuring of power system.

COB2: To study the new trends in operation and control in deregulated power systems

COB3: To understand the functioning of different electric utility markets in united states

COB4: To study the OASIS and ATC in deregulated power system.

COB5: To explore the electricity trading in restructured environment.

MODULE I OVERVIEW OF POWER SYSTEMRESTRUCTURING 9

Restructuring Models: PoolCo Model, Bilateral Contracts Model, Hybrid Model - Independent System Operator (ISO): The Role of ISO - Power Exchange(PX): Market Clearing Price (MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic Markets - Market Power - Stranded costs – Impact of losses- scheduling of operating reserves.

MODULE II KEY ISSUES IN RESTRUCTURING 9

Transmission Pricing: Contract Path Method, The MW-Mile Method - Congestion Pricing: Congestion Pricing Methods, Transmission Rights - Management of Inter-Zonal/Intra Zonal Congestion: Solution procedure, Formulation of Inter-Zonal Congestion Sub problem, Formulation of Intra- Zonal Congestion Sub problem.

MODULE III ELECTRIC UTILITY MARKETS IN THE UNITED STATES 8

California Markets: ISO, Generation, Power Exchange, Scheduling Coordinator, UDCs, Retailers and Customers, Day-ahead and Hour-Ahead Markets, Block forwards Market, Transmission Congestion Contracts(TCCs) - New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO.

MODULE IV OPEN ACCESS SAMETIME INFORMATION SYSTEM & AVAILABLE TRANSFER CAPABILITY (ATC) 12

FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Definition of Available Transfer Capability (ATC)- Calculation of ATC using network response method -Formulation of D.C. Optimal Power Flow (DCOPF) model for

assessment of Available Transfer Capability (ATC), assessment of Simultaneous ATC (SATC) and Congestion Management -Numerical examples for the above problems.

MODULE V ELECTRIC ENERGY TRADING 7

Essence of Electric Energy Trading - Energy Trading Framework: The Qualifying factors - Derivative Instruments of Energy Trading: Forward Contracts, Futures Contracts, Options, Swaps, Applications of Derivatives in Electric Energy Trading – Brokers in electricity trading – Green power trading.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Mohammad Shahidehpour and Muwaffaq Almoush, “Restructured Electrical Power systems: Operation, Trading and Volatility”, Marcel Dekkar, Inc., 2001.

REFERENCES:

1. G.Zaccour, “Deregulation of Electric Utilities”, Kluwer Academic Publishers, 1998.
2. M.Ilic, F. Galiana and L.Fink, "Power Systems Restructuring : Engineering and Economics", Kluwer Academic Publishers, 2000.
3. Editor: Loi Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", John Wiley and sons Ltd, 2001.
4. K.Bhattacharya, M.H.J.Bollen and J.E.Daader, "Operation of Restructured Power Systems", Kluwer Academic Publishers, 2001.
5. J.H.Chow,F.F.Wu and J.A.Momoh, "Applied Mathematics for restructured electric power systems: Optimization, Control and Computation Intelligence", Springer 2004.
6. F.C.Schweppe, M.C.Caramanis, R.D.Tabors and R.E.Bohn, "Spot Pricing of Electricity", Kluwer Academic Publishers, 2002.
7. Rajesh Joseph Abraham, Automatic Generation Control : Traditional and Deregulated Environments”, LAP Lambert Academic Publishing, September 2010.

COURSE OUTCOMES:

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

CO1: explain the process of restructuring and perform the market clearing and settlement.

CO2:compute transmission pricing and perform inter zonal and intra zonal congestion management.
CO3:explain the operation of different electricity markets in United States.

CO4:interpret the real time information available in an OASIS and compute the ATC and perform congestion management in restructured power systems.
CO5:carry out competitive energy trading in restructured power systems.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	H	L	L	L	L	H	M	H	H	L
CO2	H	H	H	H	H	L	L	L	L	H	M	H	H	L
CO3	H	H	H	M	H	L	L	L	L	H	M	H	H	L
CO4	H	H	H	H	H	L	L	L	L	H	M	H	H	L
CO5	H	M	H	M	H	M	L	L	L	H	M	H	H	L

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.
Statement: The learners of this course can get decent work and earn financial benefits.

SDG 9: Industry, innovation and infrastructure.
Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure.

EEEY 002	EHV POWER TRANSMISSION	L	T	P	C
SDG: 8, 9, 12		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the need for long EHV & UHV transmission lines.

COB2: To study the calculation procedures to obtain line parameters, conductor voltage gradients and electric field produced in the vicinity of the line.

COB3: To study about the audible noise and radio interference caused by corona and methods to regulate them.

COB4: To acquire knowledge on corona and its impact.

COB5: To gain knowledge on electric field produced by EHV lines.

MODULE I INTRODUCTION 9

Indian Power Scenario - Power Scenario in Tamil Nadu - Conventional and non-conventional methods of power generation details in India - Choice of economic voltage - standard transmission voltages - problems with long EHVAC lines - need for compensation - FACTS devices - HVDC transmission.

MODULE II LINE PARAMETERS 9

Types of conductors - bundled conductors - various line configurations of EHVAC lines - line resistance - Maxwell's potential coefficient matrix - Inductance and capacitance matrices of multi conductor untransposed / transposed lines - sequence inductances and capacitances - line parameters for modes of propagation in case of travelling wave propagation.

MODULE III LINE LOADINGS AND VOLTAGE GRADIENT ON CONDUCTORS 9

Temperature rise of line conductors and current carrying capacity of lines - surge impedance loading - Power handling capacity of long lines - EHVAC and HVDC alternatives - Line loss - mechanical vibrations / oscillations of line conductors and their reduction – Charge - potential relations for multi conductor lines - surface voltage gradients of bundled conductors - gradients factors and their use - distribution of voltage gradient on sub conductors of bundle - voltage gradients on conductors in the presence of ground wires on towers.

MODULE IV EFFECTS OF CORONA 9

Corona Power loss and its comparison with leakage loss and line I^2R Loss -

Audible noise generation and its characteristics - limits for audible noise -Day-Night equivalent noise level - Radio Interference (RI) due to corona pulse generation and its properties - limits on RI fields.

MODULE V EFFECT OF ELECTRIC FIELD PRODUCED BY EHV LINES **9**

Effects of EHV lines on heavy vehicles - calculation of electric field of EHVAC lines - Effect of high fields on humans, animals and plants - measurement of electric fields - Induced voltages in unenergized circuit of a double circuit line - induced voltages in insulated ground wires - electromagnetic interference.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission engineering”, Second Edition, New Age International Pvt. Ltd, 2011.

REFERENCES:

1. Power engineer’s Hand book, Revised and Enlarged 6th Edition, TNEB Engineer’s Association, October 2002.
2. Microtran Power system Analysis Corporation, Microtran Reference Manual Vancouver Canada, (Website: www.microtran.com)

COURSE OUTCOMES:

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

CO1: analyze power scenario of India and major countries of the world, history of growth of electrical industry and its latest development.

CO2: obtain line parameters for analysis with symmetrical and unsymmetrical power frequency operation and modes of operation with travelling wave propagation.

CO3: obtain power carrying capacity of EHVAC and HVDC lines of various lengths.

CO4: work out voltage gradients on EHVAC and HVDC lines with bundled conductors analytically and by using pre-calculated charts.

CO5: identify the occurrence of corona and regulate its effects in the form of audible and radio noises.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	H	H	M	L	M	H	H	H	L	H	M	M	H
CO2	M	H	M	M	H	H	H	H	M	M	H	M	H	L
CO3	H	H	H	M	H	M	L	H	M	L	M	H	M	H
CO4	H	M	M	H	L	H	M	L	L	H	H	H	H	H
CO5	H	M	L	H	H	M	L	M	M	M	H	H	H	L

Note:L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth
Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 9: Industry, innovation and infrastructure
Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure.

SDG 12: Responsible consumption and production.
Statement: Application of knowledge obtained from this course will lead to reasonable consumption and production.

EEEY 003	POWER QUALITY	L	T	P	C
SDG: 3, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To study the various terms associated with Power Quality problems.

COB2: To study the Harmonic sources and its evaluation.

COB3: To gain knowledge on compensation techniques and harmonics design.

COB4: To study about Power Quality monitoring and measurements.

COB5: To acquaint with power quality issues in distributed generation.

MODULE I INTRODUCTION 8

Power Quality Definition – Power Quality Problems, Causes and Consequences, Terms and Definitions- IEC Standards – Transients, Voltage Imbalance, Waveform distortion, Power frequency variations, DC offset, Electric Noise, Voltage Fluctuation and Flicker Sources of Sags and Interruptions - Estimating Voltage Sag Performance - Solutions at the End-User Level.

MODULE II HARMONICS 10

Harmonics versus Transients -Voltage versus Current Distortion- Harmonic Distortion Evaluations – End users, utility - Harmonic Indices -Harmonic Sources from Commercial Loads - Harmonic Sources from Industrial Loads Harmonic Distortion - Principles for Controlling Harmonics- Locating Harmonic Sources - System Response Characteristics - Effects of Harmonics - IEEE/IEC standards.

MODULE III COMPENSATION TECHNIQUES FOR POWER QUALITY 10

Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples-Dynamic Voltage Restorer (DVR) with and without energy support- Design, Control and Phasor Analysis. Harmonic Filter Design (both active and passive filters).

MODULE IV POWER QUALITY MONITORING AND ANALYSIS 9

Assessment of Power Quality Measurement Data-Harmonic Studies – Devices for Controlling Harmonic Distortion- Monitoring considerations: Power line disturbance analyzer, power quality measurement equipment, harmonic / spectrum analyzer, flicker meters, disturbance analyzer.

MODULE V DISTRIBUTED GENERATION AND POWER QUALITY 8

Resurgence of DG-DG Technologies – Interfacing DG to the Utility System -Power Quality Issues - Operating Conflicts - DG on Distribution Networks – Optimal allocation of Distributed Generation - Interconnection Standards (IEC).

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. Roger C.Durgan, Mark F .Mc Granhagan, Suryasantoso, “Electrical Power System Quality” ,Mc Graw Hill, 2nd edition, 2003.
2. Power Quality Problems and Mitigation Techniques by Bhim Singh and Ambrish Chandra, Wiley., 2015.
3. Arindam Ghosh, “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.

REFERENCES:

1. Heydt, G.T., ‘Electric Power Quality’, Stars in a Circle Publications, Indiana,2nd edition 1996.
2. Bollen, M.H.J., ‘Understanding Power Quality Problems: Voltage sags and interruptions’, IEEE Press, New York, 2000
3. Arrillaga, J, Watson, N.R., Chen, S., ‘Power System Quality Assessment’, Wiley, New York, 2000.
4. Surajit Chattopadhyay, Madhu chhanda Mitra,Samarjit Sengupta, “Electric Power Quality”, Springer, 2010.

COURSE OUTCOMES:

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

CO1: Identify the power quality issues and its importance.

CO2:identify the presence of harmonics and evaluate it.

CO3: analyse the power quality distortions and implement mitigation techniques.

CO4: To implement Power Quality monitoring and measurements techniques on various power quality issues.

CO5: To locate the Power Quality disturbances in distributed generations and to nullify it.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	L	L	L	L	L	L	L	L	L	L	H	M
CO2	H	H	L	L	M	L	L	L	L	L	M	L	H	H
CO3	L	L	L	M	L	L	M	L	L	L	L	L	H	H
CO4	L	L	L	M	L	L	M	L	L	L	L	L	H	H
CO5	L	L	L	M	L	L	M	L	L	L	L	L	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG No.3 Good health and well-being.
Statement: Understanding of the fundamentals power quality issues can help in designing systems to promote good health and well-being.

SDG 8: Decent work and economic growth.
Statement: The learners of this course can get decent work and earn financial benefits and they can work in electrical engineering filed.

EEEY 004	POWER SYSTEM PLANNING AND RELIABILITY	L	T	P	C
SDG: 3, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn load forecasting in power systems.

COB2: To study basic probability theory and concepts of reliability analysis.

COB3: To familiarize factors influencing the reliability of generation systems, transmission systems and distribution systems.

COB4: To understand the factors influencing the reliability of transmission systems and expansion planning.

COB5: To explore distribution planning in power system.

MODULE I INTRODUCTION TO POWER SYSTEMS AND LOAD FORECASTING **9**

A perspective: brief introduction to structure of power systems, growth of power system in India, present Indian power industry, GRID formation, concept of National GRID. Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting based on discounted multiple regression technique - Weather sensitive load forecasting - Determination of annual forecasting – Use of AI in load forecasting.

MODULE II INTRODUCTION TO RELIABILITY ANALYSIS **9**

Review of probability distribution, binomial distribution and exponential distribution – Network modeling and evaluation of simple and complex systems – System reliability evaluation using probability distributions – Frequency and duration techniques. Reliability concepts: Meantime to failure – Series and parallel systems – MARKOV process – Recursive technique.

MODULE III GENERATION SYSTEM RELIABILITY ANALYSIS **9**

Probabilistic generation and load models - Determination of reliability of isolated and interconnected generation systems – Energy transfer and off peak loading.

MODULE IV TRANSMISSION SYSTEM RELIABILITY ANALYSIS AND EXPANSION PLANNING **9**

Deterministic contingency analysis - Probabilistic load flow - Fuzzy load flow - Probabilistic transmission system reliability analysis - Determination of reliability indices like LOLP and expected value of demand not served- Basic concepts on expansion planning - Procedure followed to integrate transmission system planning, current practice in India.

MODULE V DISTRIBUTION SYSTEM PLANNING AND RELIABILITY 9

Introduction, sub transmission lines and distribution substations - Design primary and secondary systems - Distribution system protection and coordination of protective devices. Distribution system reliability evaluation: Reliability analysis of radial systems with perfect and imperfect switching.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. R.L.Sullivan, "Power System Planning", Heber Hill, 1987.

REFERENCES:

1. Roy Billington, “Power System Reliability Evaluation”, Gordan& Breach Scain Publishers, 1990.
2. A.S.Pabla, “Electric Power Distribution”, Tata Mc Graw-Hill Publishing Company, 5th edition, 2003.
3. TurenGonen, “Electric Power Distribution System Engineering”, McGraw Hill, 1986.
4. TurenGonen, “Electric Power Transmission System Engineering Analysis and Design”, McGraw Hill, 2nd Edition, 2010.
5. Eodrenyi, J., “Reliability Modelling in Electric Power System”, John Wiley, 1980.
6. B.R. Gupta, “Power System Analysis and Design”, S.C hand, New Delhi, 2003.

COURSE OUTCOMES:

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

CO1:carry out contingency analysis in transmission systems.

CO2:apply the probabilistic methods for evaluating the reliability of generation and transmission system.

CO3:design different model of system components in reliability studies.

CO4:design the expansion planning of power system.

CO5:forecast the load using different regression models.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	M	M	H	L	L	L	L	M	H	M
CO2	H	H	H	H	M	L	H	L	L	L	M	L	H	H
CO3	L	H	H	M	H	M	L	L	L	L	M	M	H	H
CO4	H	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 9: Build resilient Infrastructure, to support economic development and human well-being with a focus on affordable and equitable access for all.

Statement: The complete understanding of this course lead to sustainable industrialization and promote economic development.

EEEY 005	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the traditional topics associated with processing of deterministic digital signals.

COB2: To understand the significance of estimation of power spectral density

COB3: To familiarize recent developments that promise to have a broad impact on digital signal processing.

COB4: To learn the basics of multi rate DSP, Wavelets, multi resolution analysis and their interpretation and use

COB5: To explore basic DSP programming.

MODULE I PARAMETRIC METHODS FOR POWER SPECTRUM ESTIMATION 9

Relationship between the auto correlation and the model parameters – The Yule – Walker method for the AR Model Parameters – The Burg Method for the AR Model parameters – unconstrained least-squares method for the AR Model parameters – sequential estimation methods for the AR Model parameters – selection of AR Model order.

MODULE II ADAPTIVE SIGNAL PROCESSING 9

FIR adaptive filters – steepest descent adaptive filter – LMS algorithm – convergence of LMS algorithms – Application: noise cancellation – channel equalization – adaptive recursive filters – recursive least squares.

MODULE III MULTIRATE SIGNAL PROCESSING 9

Decimation by a factor D – Interpolation by a factor I – Filter Design and implementation for sampling rate conversion: Direct form FIR filter structures – Polyphase filter structure.

MODULE IV SPEECH SIGNAL PROCESSING 9

Digital models for speech signal : Mechanism of speech production – model for vocal tract, radiation and excitation – complete model – time domain processing of speech signal:- Pitch period estimation – using autocorrelation function – Linear predictive Coding: Basic Principles – autocorrelation method – Durbin recursive solution.

MODULE V WAVELET TRANSFORMS 9

Fourier Transform: Its power and Limitations – Short Time Fourier Transform – The Gabor Transform - Discrete Time Fourier Transform and filter banks – Continuous Wavelet Transform – Wavelet Transform Ideal Case – Perfect Reconstruction Filter Banks and wavelets – Recursive multi-resolution decomposition – Haar Wavelet – Daubechies Wavelet.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Pearson, Fourth Edition, 2007.

REFERENCES:

1. Sanjit. K.Mitra, “Digital Signal Processing: A computer based approach”, Tata McGraw Hill, second edition, 2004.
2. A.V.Oppenheim and R.W Schafer, Englewood, “Digital Signal Processing”, Prentice Hall, Inc. 2006.
3. B. Venkatramani & M.Bhaskar, “Digital Signal Processors architecture, Programming and applications”, Tata McGraw Hill, 2002.
4. Andreas Antoniou, “Digital signal Processing”, Tata McGraw Hill, second edition, 2008.
5. Stewen W. Smith, “Digital signal Processing – A practical guide for Engineers and scientist”, Elsevier Science, 2003.

COURSE OUTCOMES:

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

CO1: choose appropriate spectrum estimation techniques for processing the signal

CO2: apply appropriate adaptive algorithm for processing signals.

CO3: implement the multi-rate processing wavelet transform and time-frequency analysis techniques to solve real time process.

CO4: develop the digital models of speech processing.

CO5:analyze wavelet transforms for signal and image processing-based applications.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	M	L	H	L	L	L	L	L	H	M
CO2	H	M	H	M	M	L	M	L	L	L	M	L	H	H
CO3	L	H	H	L	M	L	L	L	L	L	L	L	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: To develop resilient communication and sustainable industrialization and foster innovation.

Statement:
The holistic understanding of digital signal processing leads to advanced communication which helps countries to engage in the digital economy and boost their economic competitiveness and well-being.

EEEY 006	INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN	L	T	P	C
SDG: 8, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on motor starting studies.

COB2: To understand the need for Power Factor correction and to study the various methods that are used in the Power Factor Correction studies.

COB3: To learn about the sources of harmonics, evaluate the harmonics present in the power system and mitigate them by filters.

COB4: To explore the sources that can cause the voltage flicker and find solutions to minimize the flicker.

COB5: To acquire knowledge on the ground grid analysis.

MODULE I MOTOR STARTING STUDIES 9

Introduction - Starting Methods – Frequency of starting – NEMA Motor Design Letters - Average starting torque and acceleration – Motors for Hazardous areas - Service factor – Voltage Drop Calculations - Case study.

MODULE II POWER FACTOR CORRECTION STUDIES 9

Introduction - System description and Modeling - Acceptance criteria - Frequency Scan Analysis - Voltage Magnification Analysis - Sustained Over voltages - Switching Surge Analysis - Back-to-Back Switching – Case Study.

MODULE III HARMONIC ANALYSIS 9

Harmonic Sources - System Response to Harmonics – Design recommendations for mitigation of Harmonics - Harmonic Filters – Harmonics and Resonance-IEEE / IEC standards for Harmonic Distortion levels - Case Study.

MODULE IV FLICKER ANALYSIS 9

Sources of Flicker in Industrial Power Plants – Types of Flickers – Voltage Flicker in an Arc Furnace - Arc Furnace Load – Flicker Curves - Minimizing the Flicker Effects – Case study.

MODULE V GROUND GRID ANALYSIS 9

Introduction – Different types of Grounding - Ground Grid Calculations - Improving the Performance of the Grounding Grids – IEEE/IEC standards - Case study.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Ramasamy Natarajan ,"Computer Aided Power System Analysis", Marcel Dekker Inc.,2002 .

REFERENCES:

1. Duncan Glover J., Mulukutla Sarma S., Thomas Overbye, “Power System Analysis and Design", 2011.
2. Turan Gonen,"Electrical Power Transmission System Engineering: Analysis and Design", Mcgraw Hill publishers, 1986.
3. Sen, S.K., "Principles of electrical machine Designs with Computer Programmes", Oxford and IBH Publishing Co.Pvt. Ltd., New Delhi, 1987.

COURSE OUTCOMES:

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

CO1:choose appropriate starting methods of induction motor and to perform calculations on voltage drop and acceleration time.

CO2: perform power factor correction studies.

CO3: identify and to analyze harmonics.

CO4: identify the flicker and to minimize it.

CO5:perform grounding grid analysis.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	M	H	H	M	L	L	L	M	H	H	H
CO2	H	H	H	L	H	L	M	L	L	L	M	L	H	M
CO3	H	H	H	L	H	L	M	L	L	L	M	L	H	M
CO4	H	H	H	H	H	L	M	L	L	L	M	L	H	M
CO5	H	H	H	H	H	L	M	L	L	L	M	L	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas such as power devices etc.

SDG 9: Industry, innovation and infrastructure.

Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure.

EEEY 007	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
SDG: 8, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To study EHVAC and HVDC systems.

COB2: To learn about HVDC controller circuit with various pulses.

COB3: To acquire knowledge on HVDC converters, system control and development of MTDC systems

COB4: To gain knowledge on Harmonics and design of filters.

COB5: To study about power flow analysis in an integrated EHVAC - HVDC system.

MODULE I COMPARISON OF EHVAC AND HVDC SYSTEMS 8

Technical and economic problems in bulk power transmission over long distances using EHV / UHV AC lines - HVDC alternatives for transmission - Description of HVDC systems - its application - comparison of EHVAC and HVDC systems.

MODULE II ANALYSIS OF HVDC CONVERTERS 9

Planning of HVDC transmission - modern trends in HVDC transmission - DC breakers - U/G cable transmission - VSC based HVDC - pulse number - choice of converter configuration - simplified analysis of Graetz circuit - 6 pulse converter bridge characteristics - generation of harmonics and filtering.

MODULE III ANALYSIS AND CONTROL OF HVDC SYSTEMS 10

Twelve pulse converter characteristics - its advantages - detailed analysis of Converters - Principles of DC link control - converter / inverter control characteristics - system control hierarchy - firing angle control - current and extinction angle control - power control - higher level controllers– HVDC systems simulation: modeling of HVDC systems for digital simulation.

MODULE IV MULTI TERMINAL HVDC SYSTEMS 9

Introduction to MTDC systems – potential applications of MTDC systems – Types of MTDC systems – Control and protection of MTDC systems – Detailed study about developments of MTDC systems.

MODULE V POWER FLOW ANALYSIS 9

Per unit system for DC quantities – modeling of DC links – solution of DC power flow – solution of AC – DC power flow – case studies- Application in Wind Power generation.

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. J. Arrillaga, “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983.
2. P. Kundur, “Power System stability and Control”, Tata McGraw Hill, 1993.

REFERENCES:

1. K.R. Padiyar, “HVDC Power Transmission Systems”, New Age International Pvt Ltd., New Delhi, 2002.
2. V.K. Sood, “HVDC and FACTS Controllers - Applications of Static Converters in power system”, Kluwer Academic Publishers, April 2004.

COURSE OUTCOMES:

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

CO1: identify the situations where HVDC transmission is a better alternative to EHVAC transmission

CO2:implement converter/Inverter for power control.

CO3: develop MTDC systems.

CO4: perform power flow analysis used for Integrated EHVAC-HVDC system.

CO5: simulate and analyze the steady-state performance of the EHVAC-HVDC system.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	L	M	H	M	H	L	L	L	L	L	H	M
CO2	H	L	H	H	L	H	M	L	L	L	M	L	H	H
CO3	H	H	M	M	M	L	L	L	L	L	L	L	H	H
CO4	M	H	M	H	M	H	H	L	L	L	M	M	H	M
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and wellbeing.
Statement: Understanding of the fundamentals of this course can help in designing systems to promote good health and well-being.

SDG 8: Decent work and economic growth.
Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

EEEY 008	WIND ENERGY CONVERSION SYSTEMS	L	T	P	C
SDG: 7, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the fundamentals of wind power.

COB2: To study about the wind turbine components, power generation machinery, and its control systems.

COB3: To study about the various types of wind turbines.

COB4: To gain knowledge on the wind turbine dynamic behaviour when integrated to grid and in standalone operation.

COB5: To acquire knowledge on power electronic components used in WECS.

MODULE I INTRODUCTION 9

Introduction-Historical Development and current status of Wind power-Generators and Power Electronics for wind turbines - Power System Impacts of Wind turbines-Wind speed estimation-wind speed measurements-Rayleigh distribution-Maximum Power obtainable-Bertz limit-Power coefficient –aerodynamics of Wind rotor-Blade element theory-aerodynamic efficiency-Wind energy Conversion System Components.

MODULE II WIND TURBINE 7

Types of Wind Turbine-Rotor design consideration-Tip speed ratio-blade profile-Power regulation-Yaw control –Pitch angle control-stall control-schemes for maximum power extraction.

MODULE III FIXED SPEED AND VARIABLE SPEED SYSTEMS 8

Fixed speed and variable speed wind turbine- Need of variable speed systems-Power-wind speed characteristics-Generation schemes with fixed and variable speed turbines-Comparison of different schemes.

MODULE IV MODELING AND SIMULATION OF FIXED SPEED AND VARIABLE SPEED WIND GENERATORS 11

Modeling of Fixed speed Induction generator-axes transformation-flux linkage equations-voltage equations-state equations-modeling of variable speed DFIG for Wind Energy Conversion Systems-Converter Control System- transient stability simulation of fixed speed induction generator using EUROSTAG 4.3-Doubly Fed Induction Generator(DFIG) modeling - controller modeling -modeling of DFIG in

EUROSTAG - transient stability simulation of power systems with induction generators using EUROSTAG 4.3.

MODULE V POWER ELECTRONICS IN WIND ENERGY CONVERSION SYSTEM AND GRID CONNECTED SYSTEMS **10**

Induction generator-Controlled firing angle scheme with AC and DC side Capacitor-Scalar method-flux vector scheme-Control scheme for Synchronous generator with variable speed drive-Variable speed synchronous generator control with boost converter- Stand alone and Grid Connected WECS system-Grid connection Issues-Impacts of wind power on Power System Stability- Storage technologies.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. S.N.Bhadra, D.Kasthra, S.Banerjee, “Wind Electrical Systems”, Oxford Higher Education, 2005.

REFERENCES:

1. Thomas Ackermann, ”Wind Power in Power System”, Wiley 2012.
2. L.L.Freris ,"Wind Energy conversion Systems", Prentice Hall, 1990.
3. Jian Zhang, Adam Dysko, John O'Reilly, William E. Leithead," Modeling and performance of fixed-speed induction generators in power system oscillation stability studies", Electric Power System Research Vol. 78,pp: 1416-1424,2008.
4. Andre´s Feijoo, Jose Cidras, Camilo Carrillo, "A third order model for the doubly-fed induction machine", Electric Power Systems Research 56 (2000)121-127.
5. Eurostag 4.3 Theory Manual Part I.
6. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
7. E.W. Golding, "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge, 1976.
8. S.Heir, "Grid Integration of WECS", Wiley 1998.

COURSE OUTCOMES:

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

CO1:recognize the need of renewable energy technologies and their role in the world energy demand.

CO2:identify and mathematically model the wind turbine components, calculate the available wind power, predict mechanical loads based on design, and discuss the generation of electrical power.

CO3:simulate the wind turbine dynamic system behaviour with integration of component, and control for given real time application.

CO4:mathematically model and simulate the transient and steady state performance of the stand-alone and grid connected wind generators using EUROSTAG, MATLAB, CYME packages.

CO5:analyse the wind power integration issues and their mitigation techniques and identify the present and the future energy storage technologies used in standalone and grid connected operation.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	M	M	M	L	L	L	L	L	H	M
CO2	H	L	H	M	M	L	M	L	L	L	M	M	H	H
CO3	L	H	L	M	M	M	L	L	L	L	L	L	H	M
CO4	L	M	M	H	M	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Affordable and Clean Energy.

Statement: Electrical Engineering contributes to clean sustainable energy, by generating, storage and transport electricity and help to produce climate neutral power to the world.

SDG 8: Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Decent Work and Economic Growth is supported via an increasing supply of competent engineers who will help solve the challenges of the future in all areas of everyday life. Most of the engineers graduated from Electrical Engineering stay in the area and support the economic growth and viability of local companies.

EEEY 009	POWER DISTRIBUTION SYSTEMS	L	T	P	C
SDG: 8, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basics of distribution systems.

COB2: To gain knowledge on distribution feeders and substation design.

COB3: To acquire knowledge on voltage drop and power loss analysis of distribution system.

COB4: To understand the protection devices and practices followed in distribution system.

COB5: To understand the concepts of reactive power compensation in distribution system.

MODULE I INTRODUCTION TO DISTRIBUTION SYSTEMS 9

General, an overview of the role of computers in distribution system planning Load modeling and characteristics: definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics.

MODULE II DISTRIBUTION FEEDERS AND SUBSTATIONS 9

Design consideration of Distribution feeders: Radial and loop types of primary feeders- voltage levels- feeder loading. Design practice of the secondary distribution system-Location of Substations: Rating of a Distribution Substation service area with primary feeder - Substation application curves- benefits derived through optimal location of substations. Substation bus schemes.

MODULE III SYSTEM ANALYSIS 9

Voltage drop and power loss calculations: Derivation for voltage drop and power loss in lines- manual methods of solution for radial networks - three-phase balanced primary lines- non-three-phase primary lines.

MODULE IV PROTECTIVE DEVICES AND COORDINATION 9

Objectives of distribution system protection - types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers-Coordination of protective devices: General coordination procedure.

MODULE V CAPACITIVE COMPENSATION FOR POWERFACTOR CONTROL 9

Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched) - power factor correction, capacitor location. Economic justification - Procedure to determine the best capacitor location.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. TuranGonen, “Electric Power Distribution System Engineering”, Mc.GrawHill Book Company, 2014.

REFERENCES:

1. A.S.Pabla, “Electric Power Distribution”, Tata Mc Graw-Hill Publishing Company, 4th edition,2000.
2. V.Kamaraju, “Electrical Power Distribution Systems”, Tata Mc Graw Hill publication, 2017.

COURSE OUTCOMES:

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

CO1:apply the basics of power distribution system.

CO2:design distribution feeders and substations.

CO3:perform voltage drop and power loss calculations.

CO4:perform fault calculations.

CO5:carry out reactive power compensation in distribution system.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	L	L	L	L	L	L	L	L	M	L	M	L
CO2	H	H	H	M	H	H	L	H	M	H	H	H	H	M
CO3	H	H	H	M	H	H	L	H	M	H	H	H	H	M
CO4	H	H	H	M	H	H	L	H	M	H	H	H	H	M
CO5	H	H	H	M	H	H	L	H	M	H	H	H	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.
Statement: The learners of this course can get decent work and earn financial benefits.

SDG 9: Industry, innovation and infrastructure.
Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure.

EEEY 010	ELECTRICAL TRANSIENTS IN POWER SYSTEMS	L	T	P	C
SDG: 8, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To study transmission line modelling.

COB2: To understand the fault analysis in transmission line.

COB3: To study about the wave propagation and lattice diagram.

COB4: To study about the generation of switching and lightning transients, their propagation on the grid.

COB5: To gain knowledge on protection against over voltages and insulation co-ordination.

MODULE I LINE MODELLING 9

Line parameters - Bundled Conductors - Maxwell potential coefficient matrices for various line configurations - L and C calculations for lines - resistance and inductance of ground return using Carson's formulae - Line modeling for Power frequency and surge over voltages.

MODULE II POWER FREQUENCY OVER VOLTAGES 9

Symmetrical components for O/H lines and computation of sequence impedance - a, ß, O and Karrenbaur's transformations - over voltages caused by unsymmetrical line faults - over voltages due to Ferranti effect and load rejection.

MODULE III PROPAGATION OF TRAVELLING WAVES 8

Wave equation and its solution - Relation between voltage and current waves-velocity of travelling waves-reflection and refraction - behavior at line terminations - multiple reflections - lattice diagram - attenuation and distortion.

MODULE IV MODAL ANALYSIS FOR MULTICONDUCTOR LINES AND LIGHTNING 11

Wave equation for multi conductor lines - general solution using modal analysis-significance of modal analysis - simple example of modal analysis – modes of propagation for a three-conductor system-Lightning and switching over voltages - their influence on line transients.

MODULE V PROTECTION AND INSULATION CO-ORDINATION 8

Protection against over voltages - shielding and non - shielding methods -back flashover - characteristics of surge arrestors - Location of surge arrestors – substation earthing - Basic Insulation levels - insulation co-ordination in 220kVand

400kV systems - Specific examples - insulation co-ordination in HVDC systems - IEEE/IEC standards.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc., New York, 1991.

REFERENCES:

1. Pritindra Chowdhari, “Electromagnetic transients in Power system”, PHI Learning. Age International (P) Ltd., Publishers New Delhi, 2008.
2. H.W. Dommel, “EMTP Theory Book”, Microtran Power System Analysis Corporation, Vancouver B.C.,1992.

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

CO1:distinguish between power frequency and surge over-voltages and model the transmission lines accordingly.

CO2:analyse the propagation characteristics of voltage and current surges in O/H lines.

CO3:analyse the propagation of travelling waves.

CO4:analyse and control power frequency over voltages due to unsymmetrical faults, Ferranti effect and load rectification.

CO5:design insulation co-ordination schemes for 220kV and 400kV systems.

Board of Studies (BoS) :
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Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	H	L	M	L	H	L	L	L	L	L	H	M
CO2	H	M	H	H	M	L	M	L	L	L	M	L	H	H
CO3	M	H	H	L	H	M	L	L	L	L	L	L	H	M
CO4	H	M	H	H	M	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas such as power devices etc.

SDG 9: Industry, innovation and infrastructure

Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure.

EEEY 011	SMART POWER GRID	L	T	P	C
SDG: 7		3	0	0	3

COURSE OBJECTIVES:

COB1: To know about the basic concept of smart grid.

COB2: To learn about the various smart grid component.

COB3: To know about the data management and automation techniques of smart grid.

COB4: To acquire knowledge on monitoring techniques for smart grid.

COB5: To know about the importance of security algorithms in smart grid.

MODULE I SMART GRID FUNDAMENTALS 9

Smart grid concepts - Architecture of smart grid system - components and control elements - Standards for smart grid system -Distributed Generation Resources and Energy Storage, Plug-in-Hybrid Electric Vehicles (PHEV) –Microgrid - Load Flow study for smart grid.

MODULE II COMPONENTS IN SMART GRID 9

Smart grid components – Communication infrastructure – sensing and Control devices –Energy harvesting technologies - Metering – Virtual power plants– Battery and other storage technologies - Benefits and cost elements - Pricing regulations – Networking Standards and integration – Analytics.

MODULE III AUTOMATION TECHNOLOGIES 9

Control centre systems – Data management principles – Smart Grid implementation standards and procedure – Advanced Metering Infrastructure – AMI protocols- Fault Detection - Islanding - Outage management – Distribution and Substation automation – communication protocols.

MODULE IV MEASUREMENT SYSTEMS AND PMU 11

Smart Meters, Measurements Technologies- Phasor Measurement Units- Optimal placement algorithm for PMUs - Wide area measurement systems – load forecasting - Monitoring GIS and Google Mapping Tools, Multi agent Systems (MAS) Technology - Intelligent Electronic Devices(IED) - Coordination between cloud computing and Smart power grids.

MODULE V SECURITY AND DATA PRIVACY IN SMART GRID 8

Security Challenges in Smart Grid Implementation - Smart Grid Security and Privacy of Customer Side Networks - Types of physical attack on smart grid

devices - Smart Grid Security Protection against False Data Injection (FDI) Attacks - End-to-End security with devices/equipment, sensors, controllers, actuators, communication and systems- Cyber security solutions for control and monitoring system- Standards with Cyber security Controls for Smart Grid - IEC 62443

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. J. A. Momoh, “Smart Grid: Fundamentals of Design and Analysis” Wiley India, 1st Edition, 2015.

REFERENCES:

1. Al-Shaer, Ehab, Rahman and Mohammad Ashiqur, “Security and Resiliency Analytics for Smart Grids’, Springer Intr., 1st Edition, 2016.
2. S. Goel, Goel, Y. Hong, V. Papakonstantinou, D. Kloza, “Smart Grid Security”, Springer-Verlag, 1st Edition, 2015
3. Ali Keyhani :” Design of Smart Power Grid Renewable Energy Systems “, First Edition , John Wiley Inc., 2011
4. Tony Flick and Justin Morehouse : “Securing the Smart Grid – Next generation Power Grid security “, Elsevier Publications,2011.
5. Stephen F Bush :Smart Grid Communication – Enabled Intelligence for Electric Power Grid, Wiley IEEE .,2014
6. James Momoh : Smart Grids , Fundamentals of Design and Analysis .,2014.
7. Mini . S. Thomas :Power System SCADA and Smart Grids.
8. Kenneth .C.Budka , Jayant G.Deshpande :Communication Networks for Smart Grids:Making Smart Grid Real , 2014.

COURSE OUTCOMES:

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

CO1: perform load flow studies insmart grid systems.

CO2: utilize the components to develop a smart grid.

CO3: apply automation techniques in smart grid.

CO4: analyse the parameters of the smart grid network.

CO5: develop appropriate cyber secure algorithm to have secure communication between meters and control centre.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	H	L	L	L	L	L	L	L	M	M	H	M
CO2	L	M	H	L	L	L	L	L	L	L	M	H	M	M
CO3	L	M	H	L	L	L	L	L	L	L	M	H	M	M
CO4	L	M	H	L	L	L	L	L	L	L	M	H	H	M
CO5	L	M	H	L	L	L	L	L	L	L	M	H	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Establishment of clean energy.

Statement: Power Company investments in renewable generations and digital innovation impact on affordable and clean energy.

EEE Y 012	DISTRIBUTED GENERATION AND MICROGRID	L	T	P	C
SDG: 8, 9, 11, 12		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on renewable based generation system to meet the growing demands.

COB2: To study about the optimal location of distributed generation system in the distribution system network.

COB3: To understand the impact of grid integration.

COB4: To learn the grid integration system with conventional and non-conventional energy sources.

COB5: To study the dc and ac micro grid.

MODULE I INTRODUCTION 8

Microgrid basic concepts – architecture - operational conditions, Microgrid: merits and demerits - functionalities and variables in microgrid - issues in microgrid. Types of microgrid (LV microgrid, MV microgrid - DC microgrid, AC microgrid, hybrid) - Microgrid as part of smarter grid Modes of operation: grid connected mode - islanded mode - transition between grid connected mode and islanded mode. primary control strategy - secondary control strategy - Control of distribution generation - demand side management - Opportunities and risk of different market players.

MODULE II DISTRIBUTED ENERGY RESOURCES AND STORAGE DEVICES 9

Distributed Energy Resources: solar – wind – CHP – MCHP – Micro turbine- Diesel generators –geo thermal –working, characteristics and mathematical modeling, Storage devices - Batteries - fuel cells - super capacitors.

MODULE III DISTRIBUTED SYSTEM EXPANSION AND CONTROLLERS 10

Power flow, short circuit and loss calculations- with and without distributed generation- Distribution system reliability analysis –Distribution system expansion planning– optimal location of distributed generation – solution technique.

Three phase converter - Three phase Voltage source Inverter (VSI) – Boost Converter – PWM Techniques - P-Q Control - Structure of the VSI PQ Controller - Power-Voltage (PV) Control Scheme - Frequency (V/f) Control Scheme.

MODULE IV PROTECTION ISSUES 9

Requirements of protection - issues in protection (LOM, Blinding of protection, unwanted islanding, lack of selectivity, failure of co-ordination between fuse and recloser) - challenges in protection scheme – Solutions for microgrid protection - digital relays- Adaptive protection scheme: centralized, decentralized– Multiagent based protection scheme – protection scheme based on variables.

MODULE V MICROGRID COMPONENTS 9

PMU basic concepts - International Electrotechnical Commission (IEC) 61850, 61850-7-420, 61850-8. Renewable Microgrid controller RMC 600. Microgrid pilots : KERI – CERTS - Intelligent Electronic Device (IED) - Microgrid Management system (MMS) - Static Transfer switch (STS) - RTU/ gateway - Smart metering – Sensing Devices.

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. Jukkalhamäki, “Integration of microgrids into electricity distribution networks” Master’s Thesis in Lappeenranta University of Technology, 2012
2. Amirhossein Hajimiragha, “Generation Control in Small Isolated Power Systems” Master of Science Thesis -Royal Institute of Technology, Department of Electrical Engineering Stockholm 2005.
3. Juan Carlos V´asquez Quintero, “Decentralized Control Techniques Applied to Electric Power Distributed Generation in Microgrids dissertation submitted for the degree of European Doctor of Philosophy, June 10, 2009.
4. Stanley H.Horowitz and Arun G. Phadke, “ Power System Relaying third edition, John Wiley & sons, 2008.

REFERENCES:

1. Taha Selim Ustun, Cagil Ozansoy and Aladin Zayegh, “ Fault current coefficient and time delay assignment for microgrid protection system with central protection unit” IEEE Transaction (accepted for publication in future issue of the journal-DOI-10.1109/TPWRS.2012.2214489.
2. Taha Selim Ustun, Cagil Ozansoy and Aladin Zayegh, “ Modeling of a centralized Microgrid Protection system and Distributed Energy Resources according to IEC 61850-7-420” IEEE Transaction on power systems, vol 27, No.3, pp 1560-1567, 2012.
3. M. Amin Zamani, AmirnaserYazdani, and Tarlochan S. , “A Communication-Assisted Protection Strategy for Inverter-Based Medium-Voltage Microgrids”, IEEE Transactions on Smart Grid, Vol. 3, No.

4,pp.2088-2099, 2012.
4. Eric Sorotomme, S.S. Venkata, Joydeep Mitra, " Microgrid protection using communication assisted digital relays" IEEE transaction on power delivery, Vol.25, No.4, pp.2789-2796, 2010.
5. Renewable Microgrid controller RMC 600 – ABB Brochure.

COURSE OUTCOMES:

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

CO1: apply the basic concepts with respect to microgrid.

CO2: model the distributed generator for distribution network.

CO3: optimally locate the distributed generator in the distribution system.

CO4: address the Issues involved in microgrid protection.

CO5: model controllers for distributed generator to interface it to the distribution system network.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	L	M	H	H	L	L	L	L	L	H	H
CO2	M	L	H	H	L	L	M	L	L	L	M	L	H	H
CO3	H	M	H	M	M	L	L	M	L	L	L	L	H	H
CO4	M	H	M	H	H	M	H	L	L	L	M	M	M	M
CO5	H	M	M	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas.

SDG 9: Build resilient Infrastructure, to support economic development and human well-being with a focus on affordable and equitable access for all.

Statement: The complete understanding of this course lead to sustainable industrialization and promote economic development.

SDG 11: Sustainable cities and communities.
Statement: Understanding the renewable energy sources helps in building sustainable cities and communities.

SDG 12: Responsible consumption and production.
Statement: Use of microgrid results in reasonable consumption and production.

EEE Y 013	STATE ESTIMATION AND CONTINGENCY ANALYSIS IN SMARTGRID	L	T	P	C
SDG: 7, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the model, management and protection of smart grid systems.

COB2: To understand the information systems used in smart grid.

COB3: To study about the power system operating states.

COB4: To gain knowledge on the contingency analysis in transmission grid.

COB5: To acquire knowledge on the state estimation models.

MODULE I SMART GRID SYSTEMS 9

Smart Grid introduction, Major systems in Smart Grid a technical perspective: Smart infrastructure system, Smart management system, Smart protection system, benefits and requirements of smart grid, Microgrid, Grid to vehicle and vehicle to grid.

MODULE II SMART INFORMATION SYSTEMS 9

Smart Metering, Smart Monitoring and Measurement, Information Management, Smart Communication Subsystem, An Overview, Wireless Technologies, wired technologies.

MODULE III CONTINGENCY ANALYSIS FOR POWER SYSTEMS 9

Contingency Analysis of Power System, Types of Violations, Low Voltage Violations, Line MVA Limits Violation, Instability Prediction.

MODULE IV CONTINGENCY STUDY OF NIGERIAN TRANSMISSION GRID 9

Case Study of Nigeria's 330kV Transmission Grid, Power System Security, Algorithm of a typical Contingency Analysis, Line Loadability, Simulation, Phasor and PMU Functions, Phasor Measurement Unit, Typical PMU Applications.

MODULE V STATIC STATE ESTIMATION MODELS 9

Power System Static- State Estimation, Exact Model, Nature of problem, Modeling, General Theory, State Estimation, Detection, Identification, Initial Tests, Approximate Model: State Estimation using P- Delta, Contingency Evaluation: P-Delta, Reactive Power and Voltage Magnitude.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Mukhtar Ahmad, “Power System State Estimation”, Lap Lambert Acad Publishers, 2013.

REFERENCES:

1. Nonyelu, Chibuzo Joseph, Prof. Theophilus C. Madueme, “Power System Contingency Analysis: A Study of Nigeria’s 330kV Transmission Grid”, Conference of Energy Source for Power Generation, University of Nigeri, Nsukka, Vol.: 4, February 2016.
2. Xinyu Tony Jiang, Joe H Chow, Bruce Fardanesh, Deepak Maragal, George Stefopoulos, Michael Raxanousky, “ Power System State Estimation using Direct Non-Iterative method”, Electrical Power and Energy Systems, Vol. 73, Pages 361-368, 2015.
3. Mrs. Veenavati Jagadish Prasad Mishra, Prof. Manisha D. Khardenvis, “Contingency Analysis of Power System”, IEEE Students’ Conference on Electrical, Electronics and Computer Science, 2012.
4. Feng Ding, C.D. Booth, “Protection and Stability Assessment in Future Distribution Networks Using PMUs”, 11th International Conference on Developments in Power Systems Protection, 2012.
5. Xi Fand, Satyajayant Misre, Guoliang Xue, Dejun Yang, “Smart Grid - The New and Improved Power Grid: A Survey”, Vol.14, Issue 4, Pages: 944 – 980, 2012.
6. Antonio Gomez Exp Bsito and Ali Abur, “Generalized Observability Analysis and Measurement Classification”, IEEE Transactions on Power Systems, Vol. 13, No3, August 1998.
7. Antonio Gomez ExpBsito and Ali Abur and Esther Rineri Ramos, “On the use of LOOP Equations in Power System Analysis”, IEEE International Symposium on Circuits and Systems, ISCAS’ 95, 15 Vol. 2, 1995.
8. Fred C. Scheweppe, and J.Wildes, “Power System Static-State Estimation, Exact Model”, Transactions on Power Apparatus and Systems, Vol.PAS-8, No1, January 1970.
9. Fred C. Schweppe, and Douglas B.Rom, “Power System Static-State Estimation, Part 2: Approximate Model”, IEEE Transactions on Power Apparatus and Systems, Vol. PAS-89, Issue 1, 1970.

COURSE OUTCOMES:

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

CO1:model smart grid power systems.

CO2: analyse smart grid information systems.

CO3:perform contingency analysis in smart grids.

CO4:perform contingency analysis in a Nigerian transmission grid.

CO5: perform the state estimation.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

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CO1	L	L	H	L	M	L	H	L	L	L	L	L	H	M
CO2	H	M	H	M	M	L	M	L	L	L	M	L	H	H
CO3	H	H	H	L	M	L	L	L	L	L	L	L	M	M
CO4	M	M	H	H	L	H	H	L	L	L	M	M	M	M
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7:Affordable and Clean Energy.
Ensure access to affordable, reliable, sustainable and modern energy for all.

Statement: Electrical Engineering contributes to clean sustainable energy, by generating, storage and transport electricity and help to produce climate neutral power to the world.

SDG 8: Decent Work and economic growth.
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Decent Work and economic growth is supported via an increasing supply of competent engineers who will help solve the challenges of the future in all areas of everyday life. Most of the engineers graduated from Electrical Engineering stay in the area and support the economic growth and viability of local companies.

EEE Y014	POWER ELECTRONIC APPLICATIONS TO POWER SYSTEMS	L	T	P	C
SDG: 8, 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the construction, theory and characteristics of the devices like MOSFET, BJT's, IGBT's and SCR.

COB2: To gain knowledge on Inverters and converters.

COB3: To study in detail about the reactive power compensation and FACTS devices.

COB4: To study about power quality and harmonics reduction methods.

COB5: To acquire knowledge on power quality issues caused due to sags and harmonics.

MODULE I AC TO DC CONVERTERS 9

Power Electronic Concepts and Power semiconductor Devices - Diodes, Transistors, SCR, MOSFET, IGBT and GTO's - Single Phase and three phase bridge rectifiers, half controlled and Fully Controlled Converters with R, RL, and RLE loads. Free Wheeling Diodes, Dual Converter, Sequence Control of Converters - Input Harmonics and Output Ripple, Smoothing Inductance - Power Factor Improvement effect of source impedance, Overlap, Inverter limit.

MODULE II DC TO AC CONVERTERS 9

General Topology of single Phase and three phase voltage and current source inverters - Need for anti-parallel feedback diodes - Multi Quadrant Chopper viewed as a Single-phase inverter- Configuration of Single-phase voltage source inverter: Half and Full bridge, Selection of Switching Frequency and Switching Device. Voltage Control and PWM strategies.

MODULE III STATIC REACTIVE POWER COMPENSATION 9

Shunt Reactive Power Compensation - Fixed Capacitor Banks, Switched Capacitors, Static Reactor Compensator, Thyristor Controlled Shunt Reactors (TCR) - Thyristor Controlled Transformer- FACTS Technology-Applications of static thyristor Controlled Shunt Compensators for load compensation, Static Var Systems for Voltage Control, Power Factor Control and Harmonic Control of Converter Fed Systems.

MODULE IV POWER QUALITY 9

Power Quality - Terms and Definitions - Transients - Impulsive and Oscillatory Transients - Harmonic Distortion - Harmonic Indices - Total Harmonic Distortion -

Total Demand Distortion- Locating Harmonic Sources Harmonics from commercial and industrial Loads -Devices for Controlling Harmonics Passive and Active Filters - Harmonic Filter Design.

MODULE V ANALYSIS OF POWER QUALITY ISSUES 9

Sources of over voltages - Capacitor switching – lightning - Mitigation of voltage swells - surge arrester. Sources of sags and interruptions, estimating voltage sag performance, motor starting sags - mitigation of voltage sags harmonics.

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. M.D.Singh, K.B.Kanchandani, “Power Electronics”, Mc Graw Hill Education, 2nd edition, 2017.
2. Muhammad H.Rashid, “Power Electronics”, Pearson, Fourth Edition, 2017.
3. Mohan Mathur.R., Rajiv.K.Varma, “Thyristor Based FACTS controllers for Electrical Transmission Systems”, IEEE press .1999.
4. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, "Electrical Power Systems Quality" McGraw Hill, 2003.
5. Soni, M.L., P.V. Gupta and Bhatnagar, "A Course in Electrical Power", Dhanpat Rai Sons, New Delhi, 1983.

REFERENCES:

1. Dr.P.S.Bimbhra, “Power Electronics”, Khanna Publishers,2014.
2. B.K.Bose, Power Electronics and A.C. Drives , Prentice Hall ,2004.
3. Tripathy, S.C., 'Electric Energy Utilization and Conservation', Tata McGraw Hill Publishing Company Ltd. New Delhi, 1991.
4. T.J.E. Miller, Static Reactive Power Compensation, John Wiley and Sons, Newyork,1982.
5. M.H.J Bollen, ‘Understanding Power Quality Problems: Voltage Sags and Interruptions’, New York: IEEE Press, 1999. Fred C. Scheweppe, and J.Wildes, “Power System Static-State Estimation, Exact Model”, Transactions on Power Apparatus and Systems, Volume: PAS-8, No1, January 1970.
6. Fred C. Schweppe, and Douglas B.Rom, “Power System Static-State Estimation, Part 2: Approximate Model”, IEEE Transactions on Power Apparatus and Systems, Volume: PAS-89, Issue 1, 1970.

COURSE OUTCOMES:

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

CO1: analyze power semiconductor devices and AC – DC converters
CO2: model and analyze inverters.
CO3: analyze basic compensating devices.
CO4: design harmonic mitigation filters.
CO5: analyze the issues like sag and harmonics in power quality.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	H	M	H	L	M	M	L	L	L	M	H	H
CO2	H	M	H	M	H	L	M	M	L	L	L	M	H	H
CO3	M	H	H	H	H	L	L	L	L	L	L	M	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth.

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas such as power devices etc.

SDG 9: Industry, innovation and infrastructure

Statement: The knowledge on this course would result in new innovative systems for industry and establishing advanced infrastructure.

EEE Y015	SPECIAL ELECTRICAL MACHINES AND CONTROLLERS	L	T	P	C
SDG: 3, 5, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the construction, principle of operation and performance of Stepping Motors.

COB2: To gain knowledge on construction, principle of operation and performance of switched reluctance motors.

COB3: To study about the construction, principle of operation and performance of permanent magnet brushless D.C. motors and PMSM.

COB4: To understand the **c**onstruction, principle of operation and performance of other special Machines.

COB5: To learn the MAGNET and ANSYS software for performance analysis of motor.

MODULE I STEPPING MOTORS 8

Constructional features, principle of operation, modes of excitation, torque equation, characteristics, Power circuit, Drive systems, Open loop and closed loop control of stepping motor, Applications.

MODULE II SWITCHED RELUCTANCE MOTORS 8

Constructional features, principle of operation, Torque equation, Power controllers Characteristics and control - Microprocessor based controller, Applications.

MODULE III PERMANENT MAGNET BRUSHLESS D.C. MOTORS AND SYNCHRONOUS MOTOR 9

Principle of operation, types, magnetic circuit analysis, EMF and Torque equations, Power Controllers, Motor characteristics and control of PMSM and BLDC motors, Applications.

MODULE IV MISCELLANEOUS MACHINES 8

Constructional features – Principle of operation and Characteristics of Hysteresis motor- Synchronous Reluctance Motor–Linear Induction motor - Repulsion motor-Applications.

MODULE V CASE STUDIES 12

Modelling and simulation – Switched Reluctance Machines – Permanent magnet BLDC Motor – PMSM – MAGNET 6.0, ANSYS software.

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.
3. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

REFERENCES:

1. Miller T J E, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
2. Naser A and BoldeaL,"Linear Electric Motors: Theory Design and Practical Applications", Prentice Hall Inc., New Jersey 1987.
3. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
4. R.Srinivasan, 'Special Electrical Machines', Lakshmi Publications, 2013.

COURSE OUTCOMES:

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

CO1: select a specific motor for various application.

CO2:implement special electric machines for different applications

CO3:analyse PMBLDC motor and PMSM.

CO4: model low power rating motor for real time applications.

CO5: design and simulate special electrical machines using MAGNET, ANSYS.

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Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO2	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO3	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO4	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO5	L	L	H	H	L	L	M	L	L	L	M	M	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and well-being.
Statement: Understanding of the fundamentals of electrical machines can help in designing systems to promote good health and well-being.

SDG 5: Gender equality
Statement: Acquiring the knowledge to help and overcome the gender barriers in work place.

SDG 8: Decent work and economic growth
Statement: The learners of this course can get decent work and earn financial benefits.

EEEY 016	SOLAR AND ENERGY STORAGE SYSTEMS	L	T	P	C
SDG: 7, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the implication of solar energy technology.

COB2: To understand the solar radiation concepts by solving numerical problems pertaining to solar radiation geometry.

COB3: To gain knowledge on the features and benefits of flat plate collectors and its applications.

COB4: To acquire knowledge on the features and benefits of concentrating collectors and its applications.

COB5: To understand the concepts related to thermal energy storage systems.

MODULE I SOLAR ENERGY BASICS 9

Basic concepts of Energy - Types of Energy-Renewable and Nonrenewable Energies- Energy alternatives and current energy scenario - Sun-Earth Relationship- Formation of the Atmosphere- Solar Radiation at Earth's surface - Air Mass- Instruments for the measurement of Solar radiation and Sunshine.

MODULE II SOLAR RADIATION 9

Solar Angles- Sun rise- Sun Set and Day length - Sun path diagrams - Solar radiation on Horizontal and tilted surfaces- Practice problems .

MODULE III NON-CONCENTRATING SOLAR COLLECTORS 9

Solar thermal collectors- Flat plate collectors - theory of flat plate collectors- Thermal Analysis- Absorber coatings- Solar Air heaters and Evacuated tube collectors- Solar cooker - Solar stills- Solar cooling and Refrigeration.

MODULE IV CONCENTRATING SOLAR COLLECTORS 9

Concentrating collectors- non-imaging collectors- Imaging collectors - parabolic trough collectors - Linear Fresnel collectors- Thermal and Performance Analysis- Practice Problems.

MODULE V THERMAL ENERGY STORAGE 9

Thermal Energy storage- Thermo chemical storage- Mechanical storage - Solar pond- types of solar ponds- Advantages- Applications.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Solar Energy- Principles of thermal collection and storage , S.P Sukhatme, Tata McGraw-Hill, New Delhi.

REFERENCES:

1. Solar Engineering of Thermal Processes by JA Duffie and WA Beckman, John Wiley, NY.
2. Twidell, J. and Tony W., Renewable Energy Resources, 2 nd Edition, Taylor & Francis 2006.
3. Principles of Solar Engineering by F Kreith and JF Kreider, McGraw-Hill.
4. Solar Photovoltaics. Fundamental Technologies and Application by Chetan Singh Solanki, PHI Publication.
5. Khan B. H., Non-Conventional Energy Resources, 2 nd Edition, Tata McGraw-Hill Education Pvt. Ltd. 2009.

COURSE OUTCOMES:

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

CO1:apply the principles of various natural phenomena to deliver solar energy.

CO2: develop basic knowledge on the solar radiation geometry and able to do calculations.

CO3:implementnon concentrating collectors for different applications.

CO4: design different concentrating solar collectors and analyze their performance.

CO5:apply the various thermal energy storage technologies in real time.

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CO1	H	H	M	L	M	M	M	L	M	L	L	L	H	L
CO2	H	H	H	H	L	M	M	L	L	M	L	L	H	L
CO3	M	M	M	M	L	M	M	L	L	L	L	L	M	M
CO4	M	M	M	M	L	M	M	L	L	L	L	L	M	M
CO5	M	M	M	M	L	M	M	L	L	L	L	L	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Affordable and Clean Energy.

Ensure access to affordable, reliable, sustainable and modern energy for all.
Statement: Understanding of solar energy technology contributes to clean sustainable energy, by generating, storage and transport electricity and help to produce climate neutral power to the world.

SDG 8: Decent Work and economic growth.
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Decent Work and economic growth is supported via an increasing supply of competent engineers who will help solve the challenges of the future in all areas of everyday life. Most of the engineers graduated from Electrical Engineering stay in the area and support the economic growth and viability of local companies.

EEEY 017	FUNDAMENTALS OF GRID CONNECTED	L	T	P	C
SDG: 7, 8	PHOTOVOLTAIC POWER ELECTRONIC CONVERTER DESIGN	3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on constructional details and characteristics of solar panels.

COB2: To study the concepts of converters for PV.

COB3: To familiarize with the characteristics of solar cells.

COB4: To study the concepts and control strategies, for extraction of maximum power from the solar power and its synchronization with the grid.

COB5: To systematically explore the possibilities of power conditioning.

MODULE I INTRODUCTION 9

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

MODULE II OVERVIEW OF PHOTO VOLTAIC SYSTEMS AND CONVERTERS 9

Grid connection standards, Solar Cell Characteristics, Solar panel and converter configurations, Converter topologies, Grid filter topologies, Temporary storage

MODULE III CONTROL OF PHOTO- VOLTAIC CONVERTERS 9

Maximum power utilization of photo voltaic power sources, DC- DC Converter Control, DC- AC Converter control, Harmonic compensation, Grid synchronization, Anti Islanding.

MODULE IV POWER CONDITIONING SCHEMES 9

DC Power conditioning Converters - Maximum Power point tracking algorithms - AC Power conditioners Synchronized operation with grid supply - Harmonic problem – building integrated PV systems.

MODULE V SYSTEM DESCRIPTION, MODELLING AND OPTIMIZATION 9

Converter topology and control description, P&O Maximum Power Point Tracker optimization, Phase Locked Loop PI Regulator, Current Regulator, Voltage Controller, Complete control system model.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Svein Erik Evju, Fundamentals of Grid Connected Photo-Voltaic Power Electronic Converter Design', Norwegian University of Science and Technology,2007.

REFERENCES:

1. H Garg & J Prakash, "Solar Energy : Fundamentals and Applications", McGraw Hill Education, 2017.
2. Solanki C.S, "Solar Photovoltaics - Fundamentals, Technologies and Applications", PHI, 2015
3. Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
4. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
5. Solar Energy , S.P. Sukhatme, Tata McGraw Hill,1987.

COURSE OUTCOMES:

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

CO1: choose components of PV systems, including solar modules, power control components, and the balance of system components

CO2: explain the principles that underlie the ability of various natural phenomena to deliver solar energy.

CO3: apply the technologies that are used to harness the power of solar energy.

CO4: carry out a credible design of a grid-connected PV system.

CO5: model and design MPPT and controllers of grid tied inverters.

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CO1	M	L	H	L	M	L	H	L	L	L	L	L	H	M
CO2	H	M	H	M	M	L	M	L	L	L	M	L	H	H
CO3	L	H	H	L	M	L	L	L	L	L	L	L	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Affordable and Clean Energy
Ensure access to affordable, reliable, sustainable and modern energy for all

Statement: Understanding of solar energy technology contributes to clean sustainable energy, by generating, storage and transport electricity and help to produce climate neutral power to the world.

SDG 8: Decent work and economic growth
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Decent Work and economic growth is supported via an increasing supply of competent engineers who will help solve the challenges of the future in all areas of everyday life. Most of the engineers graduated from Electrical Engineering stay in the area and support the economic growth and viability of local companies.

EEEY 018	ADVANCED POWER SEMICONDUCTOR	L	T	P	C
SDG: 3, 5, 8	DEVICES	3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the basics of devices selection.

COB2: To understand the static and dynamic characteristics of power semiconductor devices.

COB3:To gain knowledge of various driver circuits used in power semiconductor devices.

COB4: To understand the control and firing circuit for different devices.

COB5: Toacquire knowledge about the thermal protection of the devices.

MODULE I INTRODUCTION 9

Power switching devices overview; Attributes of an ideal switch, application requirements, circuit symbols. Power handling capability, Device selection strategy, EMI due to switching, Power diodes, Types, characteristics and rating.

MODULE II CURRENT CONTROLLED DEVICES 9

BJT's – Construction, static characteristics, switching characteristics, Power Darlington circuit, – Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy, concept of latching; Gate and switching characteristics, converter grade and inverter grade, series and parallel operation, comparison of BJT and Thyristor, steady state and dynamic models of BJT &Thyristor.

MODULE III VOLTAGE CONTROLLED DEVICES AND DRIVER CIRCUITS 9

Power MOSFETs and IGBTs, Principle of voltage-controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs, Basics of GTO, MCT, FCT, RCT and IGCT. Driver ICs**:** MOC series SCR, IR2XXX Series Full Bridge and Half Bridge MOSFET / IGBT Driver ICs.

MODULE IV FIRING AND PROTECTING CIRCUITS 9

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving circuit for power BJT. Over voltage, over current and gate protections, Design of snubbers.

MODULE V THERMAL PROTECTION 9

Heat transfer – conduction, convection and radiation, Cooling – liquid cooling, vapour – phase cooling, Guidance for heat sink selection - heat sink types and design-Electrical analogy of thermal components– Mounting types.

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. Rashid M.H., “Power Electronics circuits, Devices and Applications”, Prentice Hall India, Third Edition, New Delhi, 2008.
2. M.D. Singh and K.B.Khanchandani, “Power Electronics”, Tata McGraw Hill, 2006.

REFERENCES:

1. Vedam Subramanian, "Power Electronics", New Age International (P) Limited, New Delhi, 1997.
2. Ned Mohan, Undcland and Robins, “Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.
3. B.W. Williams, “Power Electronics – Devices, Drivers, Applications and Passive Components”, Macmillan, 1992.
4. Dr.Ing. Arendt Wintrich, Dr. Ing. Ulrich Nicolai, Dr. techn. Werner Tursky, Tobias Reimann, Application Manual Power Semiconductors, published by SEMIKRON International GmbH.

COURSE OUTCOMES:

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

CO1: determine the suitable device for the application.

CO2: explain the operation and characteristics of the semiconductor devices.

CO3:analysethe gate driver circuits and its necessity.

CO4:design heat sinks for semiconductor devices.

CO5:design protection circuit for the semiconductor devices.

Board of Studies (BoS) :

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Academic Council:

19th Academic Council held on 29.09.2022

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CO1	L	L	H	H	L	M	M	L	L	L	M	M	H	M

CO2	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO3	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO4	L	L	H	H	L	M	M	L	L	L	M	M	H	M
CO5	L	L	H	H	L		M	L	L	L	M	M	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and well-being.

Statement: Understanding of the fundamentals of power semiconductor devices can help in designing systems to promote good health and well-being.

SDG 5: Gender equality.

Statement: Acquiring the knowledge to help and overcome the gender barriers in work place.

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits.

EEEY 019	ANALYSIS OF POWER CONVERTERS	L	T	P	C
SDG: 3, 5, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To gain knowledge on the power electronic converters.

COB2: To discuss in depth the PWM strategies.

COB3: To study the Power Factor Correction (PFC) controller.

COB4: To acquire knowledge on converters and rectifiers.

COB5: To study DAB converter.

MODULE I AC – DC CONVERTER 9

Power switching devices overview; Attributes of an ideal switch, application requirements, circuit symbols. Power handling capability, Device selection strategy, EMI due to switching, Power diodes, Types, characteristics and rating.

MODULE II PERFORMANCE CHARACTERISTICS OF PHASE CONTROLLED CONVERTERS 9

Performance parameters: Dc voltage ratio – input displacement angle – displacement factor - power factor – current distortion factor- Harmonic content of DC terminal voltage and input current - THD of Two quadrant converters and one quadrant converters - reduction of reactive loading of the supply by the Two quadrant converter by means of consecutive firing angle control.

MODULE III PHASE CONTROLLED CYCLOCONVERTER 9

Symmetrical - open delta - Ring connected cycloconverter circuits- Harmonic distortion in the output voltage – General Expression for Three pulse waveform for an arbitrary firing angle control method - Harmonic series of three and six pulse cycloconverters – cosine wave control method – Firing pulse generation: Functional schemes – End stop control : reverence voltage - clamp method – pulse isolating output stage.

MODULE IV AC - AC CONVERTER AND ACTIVE FRONT END RECTIFIERS 9

Analysis of Single-phase and Three phase AC Voltage Controllers - Overview of Power Factor Correction Approaches - Unity power factor rectifiers - Resistor emulation principle – mathematical modeling – control schemes- Design of feedback compensators -front end rectifiers with real and reactive power control – Phase shifter.

MODULE V DUAL ACTIVE BRIDGE CONVERTER 9

Dual active bridge converter – circuit configuration – steady state analysis – steady state model of DC-DC DAB Converters - Steady-State Model for AC-AC DAB Converters - soft switching analysis – DAB for Solid state transformer.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. Ned Mohan, Tore M. Undeland. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., 2003.

REFERENCES:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", Pearson Education India, 2003
2. M.D. Singh, “Power Electronics” Tata McGraw-Hill Education, 07-Jul-2008.
3. Eric Monmasson, Power Electronic Converters PWM Strategies and Current Control Techniques, John Wiley & Sons, Inc, ISTE Ltd 2011.
4. D.M. Mitchell, DC-DC Switching Regulator Analysis, McGraw-Hill Ryerson, Limited, 1988.

COURSE OUTCOMES:

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

CO1:explain the operation of AC- DC Converters.

CO2:analyze performance parameters for converters.

CO3:explain the operation of cyclo converter and the various pulse generation techniques.

CO4:apply the operating principle of AC voltage controller.

CO5:analyze the various dual active bridge converters.

Board of Studies (BoS) :

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CO1	M	L	H	L	M	L	H	L	L	L	L	L	H	M
CO2	H	M	H	M	M	L	M	L	L	L	M	L	H	H
CO3	L	H	H	L	M	L	L	L	L	L	L	L	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and well-being.
Statement: Understanding of the fundamentals of power semiconductor devices can help in designing systems to promote good health and well-being.

SDG 5: Gender equality
Statement: Acquiring the knowledge to help and overcome the gender barriers in work place.

SDG 8: Decent work and economic growth
Statement: The learners of this course can get decent work and earn financial benefits.

EEEY 020	SOLID STATE AC & DC DRIVES	L	T	P	C
SDG: 3, 5, 8		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the stable steady-state operation and transient dynamics of a motor-load system.

COB2: To study the operation of the converter / chopper fed dc drive and to solve simple Problems.

COB3: To study the operation of both classical and modern induction motor drives.

COB4: To understand the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives with converter.

COB5: To gain knowledge on the current and speed controllers for a closed loop solid-state DC and AC motor drive and simulation using a software package.

MODULE I FUNDAMENTAL OF DC AND AC DRIVE 9

Components of electrical Drives-electric machines, power converter, controllers-dynamics of electric drive - torque equation - equivalent values of drive parameters - components of load torques types of loads - four quadrant operation of a motor– steady state stability– load equalization – classes of motor duty - determination of motor rating – Criteria for selection of motor for drives.

MODULE II SENSORS AND CONTROLS OF DRIVES 12

Hall Effect Sensors – Mechanical Sensors for speed and angular positions – Absolute Encoders – Incremental Encoders – Resolvers – Modeling of drive elements – Transient analysis of separately excited motor – converter control of dc motors – analysis of separately excited & series motor with 1 - phase and 3 - phase converters – dual converter – analysis of chopper controlled dc drives – converter ratings and closed loop control – transfer function of self, separately excited DC motors – linear transfer function model of power converters – sensing and feeds back elements – current and speed loops, P, PI and PID controllers – response comparison – simulation of converter and chopper fed DC drive

MODULE III SOLID STATE CONTROL OF INDUCTION MOTOR DRIVE 8

Induction motor drives -Stator control – Stator voltage and frequency control – AC chopper fed induction motor drives – Voltage source inverter – current source inverter – Cyclo-converter fed induction motor drive – Rotor control – Static rotor

resistance control and slip power.

MODULE IV SOLID STATE CONTROL OF SYNCHRONOUS MOTOR DRIVE **9**

Synchronous motor drives – Speed control of three-phase synchronous motor – drives Voltage source inverter – current source inverter fed synchronous motor drive – Z - source inverter fed synchronous motor – Cyclo-converter fed synchronous motor

MODULE V DIGITAL CONTROL OF DRIVES **7**

Microprocessor based control of drives, Phase Locked Loop, Digital technique in speed control, Selection of drives and control schemes for paper mills, Selection of drives for lifts and cranes.

L - 45; TOTAL HOURS - 45

TEXTBOOKS:

1. R. Krishnan, Electrical Motor Drives, PHI 2003.
2. G.K.Dubey, Power semiconductor controlled drives, Prentice Hall- 2000.
3. G.K.Dubey, Fundamentals of Electrical Drives, Narosa-1999.

REFERENCES:

1. A. Nasar, Boldea , Electrical Drives, Second Edition, CRC Press, 2006.
2. M. A. El Sharkawi , Fundamentals of Electrical Drives , Thomson Learning 2000.
3. W. Leohnard, Control of Electric Drives, Springer, 2001.
4. Murphy and Turnbull, Power Electronic Control of AC motors, Pergamon Press, 1973.
5. Vedam Subrahmaniam, Electric Drives, Tata McGraw Hill, 2000.

COURSE OUTCOMES:

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

CO1:analyze the system considering the steady state and dynamic characteristics.

CO2:design a closed loop control of AC and DC drives.

CO3:choose motor for various applications.

CO4:apply the software knowledge in Matlab for drive application.

CO5: design a system with suitable parameters to control a drive system.

Board of Studies (BoS) :
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CO2	H	M	H	M	M	L	M	L	L	L	M	L	H	H
CO3	L	H	H	L	M	L	L	L	L	L	L	L	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 3: Good health and well-being.
Statement: Understanding of the fundamentals of power semiconductor devices can help in designing systems to promote good health and well-being.

SDG 5: Gender equality
Statement: Acquiring the knowledge to help and overcome the gender barriers in work place.

SDG 8: Decent work and economic growth
Statement: The learners of this course can get decent work and earn financial benefits.

EEEY 021	ENERGY AUDITING	L	T	P	C
SDG: 7, 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To gain knowledge on general concepts and methodologies of energy auditing.

COB2: To understand the procedures and techniques involved in energy auditing.

COB3: To explore the possibilities of energy saving.

COB4: To study different instruments involved in energy auditing.

MODULE I GENERAL ASPECTS, METHODOLOGY AND APPROACH 9

General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management - Energy Audit: Need, Types - Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution. Energy strategy for the future, Energy conservation Act-2001 and its features.

MODULE II PROCEDURES AND TECHNIQUES 8

Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.

MODULE III EVALUATION OF SAVING OPPORTUNITIES 7

Determining the savings in Rs, Non-economic factors, Conservation opportunities, estimating cost of implementation. Energy Economic Analysis: The time value of money concept, developing cash flow models, payback analysis, depreciation, taxes and tax credit – numerical problems. Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation - Identification of losses, Improvements. Energy Balance sheet .

MODULE IV ENERGY AUDIT INSTRUMENTS 6

Basic measurements – Electrical measurements, Light, Pressure, Temperature and

heat flux, Velocity and Flow rate, Vibrations, etc. Instruments Used in Energy systems: Load and power factor measuring equipments, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis.

L - 30; TOTAL HOURS - 30

TEXTBOOK:

1. W.R.Murphy, G.Mckay 'Energy Management', Butterworth Scientific, 1981.

REFERENCES:

1. C.B.Smith 'Energy Management Principles', Pergamon Press, 1981
2. I.G.C.Dryden 'Efficient Use of Energy', London : Butterworth Scientific in collaboration with the Institute of Energy acting on behalf of the United Kingdom Department of Energy, 1982.
3. A.V.Desai 'Energy Economics', Wiley Eastern, 1990.
4. D.A. Reay 'Industrial Energy Conservation', Pergammon Press, 1977
5. Steve Doty (Author), Wayne C. Turner (Author) , 'Energy Management Handbook, Fairmont Press, 2012.
6. L.C. Witte, P.S. Schmidt, D.R. Brown 'Industrial Energy Management and Utilization', Washington : Hemisphere Publishing ; Berlin : Springer-Verlag, c 1988.
7. Bureau of Energy Efficiency, General Aspects of Energy Management and Energy Audit. New Delhi, 2016.

COURSE OUTCOMES:

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

CO1:demonstrate the importance of energy auditing.

CO2:utilize the right technique and procedure for energy auditing.

CO3:analyse the possibilities of reducing the losses and saving the energy systematically.

CO4:select appropriate instruments in the process of energy auditing.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	M	M	M	L	L	L	L	L	H	M
CO2	H	L	H	M	M	L	M	L	L	L	M	M	H	H
CO3	L	H	L	M	M	M	L	L	L	L	L	L	H	M
CO4	L	M	M	H	M	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Affordable & Clean Energy

Statement: Understanding the fundamentals of energy audit can help to identify energy-saving opportunities.

SDG 9: Industry, Innovation & Infrastructure

Statement: The thorough comprehension of energy auditing can identify safety concerns with electrical systems, wiring, and ventilation, thus making home or business safer.

EEE Y022	WIDE AREA MEASUREMENT SYSTEMS	L	T	P	C
SDG: 4, 9		2	0	0	2

COURSE OBJECTIVES:

COB1: To study the mathematical techniques applied to Wide Area Measurement.

COB2: To gain knowledge on the performance of synchro phasor measurement units

COB3: To understand the operating principle of wide area measurement systems.

COB4: To familiarize the performance of generic phasor measurement unit

MODULE I MATHEMATICAL BACKGROUND 7

Phasor representation of sinusoids - Fourier series and Fourier transform and DFT Phasor representation - Phasor Estimation of Nominal Frequency Signals - Formulas for updating phasors - Nonrecursive updates - Recursive updates - Frequency Estimation

MODULE II SYNCHRO PHASOR MEASUREMENTS 8

Need of Synchro phasor Measurements, Phasor Measurement Unit: Architecture, Functions, Optimal Placement of PMUs, phasor data concentrators and associated communication system. Visualization tools to enhance visibility and control within transmission system, PMU measurements and sampling rates State Estimation & Observability by using PMU, phasor data use for real time operation, frequency stability monitoring and trending, power oscillation, voltage monitoring and trending. Alarming and setting system operating limits. Dynamic line rating and congestion management, outage restoration. Application of PMU for wide area monitoring and control.

MODULE III WIDE AREA MEASUREMENT SYSTEM 8

Architecture, Components of WAMS, GUI (Graphical User Interface), Applications: Voltage Stability Assessment, Frequency stability Assessment, Power Oscillation Assessment, Communication needs of WAMS, WAMPAC (Wide Area Monitoring Protection & Control), RAS (Remedial Action Scheme). Standards: IEEE 1344, IEEE C37.118 (2005), IEEE Standard C37.111-1999 (COMTRADE), IEC61850 GOOSE.

MODULE IV PERFORMANCE OF A GENERIC PMU 7

The global positioning system - Hierarchy for phasor measurement systems, - Functional requirements of PMUs - Transient Response of Phasor Measurement Units - of instrument transformers, filters, during electromagnetic transients -

Transient response during power swings.

L - 30; TOTAL HOURS - 30

TEXTBOOK:

1. A.G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer Publications, 2008.

REFERENCES:

1. Joseph Euzebe Tate "Event detection and visualization based on phasor measurement units for improved situational awareness", UMI Dissertation Publishing.
2. Fahd Hashiesh, M. M. Mansour , Hossam E. Mostafa Fahd Hashiesh , M. M. Mansour , Hossam E. Mostafa ,"Wide Area Monitoring, Protection and Control: The Gateway to Smart Grids",
3. Dr. Arun G. Phadke, Dr. James S. Thorp,. "Computer Relaying for Power Systems", Wiley Publication, Second Edition.
4. Krzysztof Iniewski "Smart Grid Infrastructure & Networking", Tata McGraw Hill.

COURSE OUTCOMES:

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

CO1: model the Phasor Measurement System mathematically.

CO2: apply Phasor Measurement Unit for wide area monitoring and control.

CO3: implement wide area measurement systems for assessing power system oscillations and stability.

CO4: apply generic Phasor Measurement Unit for assessing power system oscillations and stability.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	L	M	L	M	M	L	L	L	L	H	M
CO2	H	M	H	M	M	L	M	M	L	L	M	L	H	H
CO3	H	H	H	M	M	M	M	M	L	L	L	L	H	H
CO4	H	H	H	M	M	M	M	M	L	L	L	L	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7: Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and modern energy for all.

Statement: Understanding of solar energy technology contributes to clean sustainable energy, by generating, storage and transport electricity and help to produce climate neutral power to the world.

SDG 8: Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: Decent Work and Economic Growth is supported via an increasing supply of competent engineers who will help solve the challenges of the future in all areas of everyday life. Most of the engineers graduated from Electrical Engineering stay in the area and support the economic growth and viability of local companies.

EEEY 023	POWER SYSTEM SIMULATION SOFTWARE	L	T	P	C
SDG: 9		0	0	2	1

COURSE OBJECTIVES:

COB1: To gain knowledge on various proprietary and open-source software for simulation of power systems.

COURSE DESCRIPTION:

Study of both proprietary and open-source software for simulation of power systems:

PROPRIETARY SOFTWARE

- ETAP
- CYME
- PSCAD
- EUROSTAG

OPEN-SOURCE SOFTWARE

- UWPFLOW
- PSAT
- InterPSS
- DCOPFJ
- OpenDSS
- MatDyn
- minpower
- Dome
- GridLAB-D
- OpenPMU

Assessment I: A presentation on the proprietary software available in the department and the latest open-source software.

Assessment II: Comparative study by simulating the same problem over multiple software.

Semester End: Solving a given power system problem using any one of the software.

L -30; TOTAL HOURS- 30

REFERENCES:

1. Proprietary software manual
2. Open-source software manual

COURSE OUTCOME:

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

CO1: apply the various proprietary and open-source software for simulation of power systems.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	M	L	H	L	L	L	L	L	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, to support economic development and human well-being with a focus on affordable and equitable access for all.

Statement: The complete understanding of Power System Simulation Software provides realistic forecasts of power market prices, given the forecast supply-demand situation.

EEEY 024	SIMULATION OF POWER ELECTRONIC CIRCUITS	L	T	P	C
SDG: 4		0	0	2	1

COURSE OBJECTIVES:

COB1: To study the various proprietary and open-source software for simulation of power electronic circuits.

PROPRIETARY SOFTWARE	• PSIM • PSPICE • FEADMOS • VISSIM	**08**
OPEN-SOURCE SOFTWARE	• PYTHON POWER ELECTRONICS • ZenitPCB • NgSpice • LTSpice	**07**

P - 30; TOTAL HOURS - 30

TEXT BOOK:

1. M. B. Patil, V. Ramanarayanan, V. T. Ranganathan, "Simulation of Power Electronic Circuits" Alpha Science International Limited, 2009.

REFERENCES:

1. https://powersimtech.com/products/psim/capabilities-applications
2. https://www.ti.com/tool/PSPICE-FOR-TI

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

CO1: design and simulate power electronic circuits using proprietary and open-source software.

Board of Studies (BoS) :
18th BoS of Department of EEE held on 12.07.2022

Academic Council:
19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H	H	H	L	H	L	L	L	L	L	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Quality Education

Statement: Learning of the software taught in the course will enrich the

students with quality education to build their career.

EEEY 025	ELECTRIC VEHICLES	L	T	P	C
SDG: 7		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the vehicle dynamics.

COB2: To understand the operation of electric vehicle and hybrid electric vehicle.

COB3: To gain knowledge on control of motors that are applied to electric vehicle.

COB4: To learn the role of storage devices in Electric Vehicle and its operation.

COB5: To acquire knowledge on the various charging technologies applied for EV.

MODULE I ELECTRIC VEHICLE FUNDAMENTALS 9

Vehicle Basics - vehicle model - Vehicle Resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation Tire–Ground Adhesion and Maximum Tractive Effort - Power Train Tractive Effort and Vehicle Speed - EV Power train Component Sizing - Development of Electric Vehicle in India.

MODULE II ELECTRIC VEHICLE ARCHITECTURE 9

Basics of Electric Vehicle - Hybrid Electric Vehicle - Plug-In Hybrid Electric Vehicle (PHEV)- vehicle architectures- Series Hybrid Vehicle, Parallel Hybrid Vehicle - Fuel Cell Vehicles (FCVs).

MODULE III ELECTRIC MACHINES AND DRIVES IN EVS 9

Electric Machines and Drives in EV - Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, Switched Reluctance Motor, BLDC motor, Design and Sizing of Traction Motors- Power electronics circuits used for EV.

MODULE IV STORAGE TECHNOLOGIES FOR EV 9

Different Energy Storage Technologies and its control for EVs - Batteries, Ultracapacitor, Fuel Cells - Battery Charging Control - Charge Management of Storage Devices - Flywheel Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System - Battery Management System.

MODULE V CHARGING TECHNOLOGIES FOR EV 9

EV Charging Technologies - Classification of different charging technology for EV -

charging station - Grid-to-Vehicle - Vehicle to Grid (V2G) - Vehicle to Building operations, bi-directional EV charging systems - energy management strategies used in hybrid and electric vehicle - Wireless power transfer (WPT) technique for EV charging.

L - 45; TOTAL HOURS - 45

TEXTBOOK:

1. M. Ehsani, Y. Gao, S. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles” , CRC Press, 2005.

REFERENCES:

1. Tom Denton “Electric and Hybrid Electric vehicle” Taylor and Francis Group, 2020.
2. Iqbal Husain, “Electric and Hybrid vehicles”, Design Fundamentals, CRC Press,2003.
3. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2003.

COURSE OUTCOMES:

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

CO1: apply the knowledge on vehicle dynamics.

CO2: choose components of electric vehicle for its function.

CO3: select appropriate motor drive for electric vehicle application.

CO4 : utilize batteries in electric vehicle.

CO5:apply appropriate charging technology for real time electric vehicle application.

Board of Studies (BoS) :

18th BoS of Department of EEE held on 12.07.2022

Academic Council:

19th Academic Council held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	H	L	M	L	H	L	L	L	L	L	H	M
CO2	H	M	H	M	M	L	M	L	L	L	M	L	H	H
CO3	L	H	H	L	M	L	L	L	L	L	L	L	H	H
CO4	M	M	H	H	L	H	H	L	L	L	M	M	H	H
CO5	H	M	H	H	L	H	H	L	L	L	M	M	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 7 :Establishment of clean energy.

Statement: To promote the usage of clean energy by reshaping the infrastructure of vehicle to create emission friendly transportation.

OPEN ELECTIVE COURSES

OEEY 701	ANALYTICAL TECHNIQUES	L	T	P	C
SDG: 6, 7		3	0	0	3

COURSE OBJECTIVES:

To make the students to understand the

COB1: basics in data analysis

COB2: basics and principles in volumetric and gravimetric analysis

COB3: types and principles of electro analytical methods

COB4: principles and analysis of spectroscopic techniques

COB5: the principle and methods in chromatography and thermal analysis

MODULE I DATA ANALYSIS 9

Precision and accuracy, Classification of errors, methods of minimization and elimination of errors Mean and standard deviation; absolute and relative errors; students t-test, F-test, linear regression for deriving calibration plots, covariance and correlation coefficient

Statistics for analytical experimentation: Probability, Regression analysis, Data analysis and signal enhancement.

MODULE II VOLUMETRIC METHODS OF ANALYSIS 9

Different methods of expressing concentration terms, Difference between titrimetic and volumetric analysis, Types and roles of indicators - Principle and reactions involved in neutralization, precipitation, complexometric and redox titrations, calculations involving stoichiometry – for all types of systems - Gravimetric analysis (volatilisation and precipitation methods)

MODULE III ELECTROANALYTICAL METHODS 9

Types of electrodes - Conductometric Titrations - Potentiometric titrations - pH-metry and ion-selective electrodes - Amperometric titrations - Coulometric Titrations, DM Electrode - polarography - electrogravimetry - voltammetry, cyclic voltammetry, impedance studies - Electrochemical sensors, ISFETs, CHEMFETs.

MODULE IV SPECTROPHOTOMETRIC TECHNIQUES 9

Quantitative applications of Colorimetric analysis – UV-Visible spectrophotometry – *Atomic absorption spectroscopy* (*AAS*) - atomic emission spectroscopy (AES), *Flame photometry*, ICP-AES - Fluorescence spectroscopy, Stern Volmer Equation and quantum yield calculation.

MODULE V CHROMATOGRAPHIC TECHNIQUES AND THERMAL METHODS 9

Chromatography**:** Paper, TLC and column Chromatography – Detectors in Chromatography - GC, HPLC, (hyphenated techniques GC/MS, LC/MS) and GPC -– ion exchange chromatography – Electrochromatography**:** Capillary electrophoresis and gel electrophoresis

Thermal analytical techniques: TGA, DTA, DSC, DMA – Chemisorption Techniques – TPD, TPO, TPR, TPS.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Skoog D.A., West D.M., Holler F.J. and Crouch S.R., Fundamentals of Analytical Chemistry, 8th Edition, Thomson Brooks/Cole Publication., Singapore, 2004.
2. Willard H.H., Merritt L.L., Dean J.A. and Settle F.A., Instrumental Methods of Analysis, 7th Edition, CBS Publication, New Delhi Reprint, 2004.
3. Skoog D.A., Holler F.J. and Nieman T.A., Principles of Instrumental Analysis, 5th Edition, Harcourt College Publication., Singapore, 1998.
4. Christian G.D., Analytical Chemistry, 6th Edition, John Wiley, Singapore, 2003.
5. Fifield F.W. and Kealey D., Principles and Practice of Analytical Chemistry, 5th Edition, Blackwell Publication, London, 2000.
6. Settle F. (Editor), Handbook of Instrumental Techniques for Analytical Chemistry, Pearson Education, Singapore, 2004.

COURSE OUTCOMES:

The student will be able to

CO1: analyse the numerical data without error

CO2: perform the volumetric and gravimetric analysis of chemical compounds and interpret the result

CO3: perform the electro analytical titrations and analyse the result

CO4: identify the appropriate spectral technique and do the spectral analysis and interpret the data

CO5: perform the chromatographic techniques and separate the compounds

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	M	M		M											
CO2	H	M		M											
CO3	H	M		M		H									
CO4	H	M		M	M	H									
CO5	H	M		M	M	H									

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 6: Clean Water & Sanitation
SDG 7: Affordable and Clean Energy

Statement: Through various analytical methods, innovative, cheap and affordable materials can be developed and can be employed in the area of clean water, sanitation and energy

OEEY 702 ARTIFICIAL INTELLIGENCE AND IOT L T P C

SDG: 8 3 0 0 3

COURSE OBJECTIVES:

COB1: To learn the working of intelligent agents.

COB2: To study the various search techniques and optimization of search.

COB3: To represent knowledge in first order logic**.**

COB4: To know the fundamentals of IoT.

COB5: To learn the IoT architecture and protocol stack.

MODULE I ARTIFICIAL INTELLIGENCE INTRODUCTION 9

Artificial Intelligence Foundations - Artificial Intelligence History - Agents and Environments - Structure of Agents - Problem-Solving Agents - Search Algorithms - Uninformed Search Strategies - Informed (Heuristic) Search Strategies - Heuristic Functions.

MODULE II SEARCH OPTIMIZATIONS 9

Local Search and Optimization Problem - Continuous Spaces - Nondeterministic Actions - Partially Observable Environments - Online Search Agents and Unknown Environments - Constraint Satisfaction Problems – Backtracking Search – Adversarial Search and Games - Alpha Beta Search.

MODULE III KNOWLEDGE REPRESENTATION 9

Knowledge Based Agents – Propositional Logic – First Order Logic – Inference in First Order Logic – Forward Chaining – Backward Chaining.

MODULE IV IOT FUNDAMENTALS 9

Fundamentals of IoT – Characteristics of IoT – IoT architecture and Components – Logical Design of IoT – Communication Models – IoT Communication APIs.

MODULE V IOT ARCHITECTURE AND PROTOCOLS 9

Structure – Objectives – Three layer and Five Layer Architecture – Cloud and Fog based Architecture – IoT Network Protocol Stack - IoT Technology Stack – Case Study – Applications of AI in IoT.

L – 45; TOTAL HOURS –45

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, Fourth Edition, 2020. ISBN: 978-0134610993.

2. Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, Internet of Things (IoT): Principles, Paradigms and Applications of IoT, BPB Publications, First Edition, 2020, ISBN: ISBN: 978-9389423365.

REFERENCES:

1. S. Kanimozhi Suguna, M. Dhivya, Sara Paiva, Artificial Intelligence (AI): Recent Trends and Applications, CRC Press, 2021, ISBN: 978-0-367-43136-5.
2. Vlasios Tsiatsis, Stamatis Karnouskos, Jan, Internet of Things: Technologies and Applications for a New Age of Intelligence, 2nd Edition, Academic Press, 2019, ISBN: 978-0-12-814435-0

COURSE OUTCOMES: The student will be able to

- Identify the suitable search algorithms for solving problems.
- Employ AI adversarial game search techniques while evaluating the application of more real world problems.
- Use first order logic for wide variety of applications, from planning and diagnosis to knowledge representation and reasoning.
- Apply the technologies, standards, and protocols that are best suited for low-level sensor nodes.
- Determine the most appropriate IoT Devices and Sensors based on case Studies.

Board of Studies (BoS) :
21st BoS of CSE held on 27.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2
CO1	H	M	H	L	M	-	L	-	-	L	-	M	H	M
CO2	H	H	H	L	M	-	L	-	-	L	-	H	M	H
CO3	H	H	H	L	L	-	-	-	-	L	-	L	M	H
CO4	H	M	H	L	L	-	-	-	-	-	-	M	M	H
CO5	H	H	H	L	L	-	-	-	M	-	M	M	H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Statement: The objective of AIoT is to improve human-machine interactions,

IoT operations and data management and analytics.

OEEY 703	BIOMATERIALS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To enable the students understand importance of and properties of Biomaterials

COB2: To familiarize the students with different orthopaedic materials.

COB3: To understand different cardiovascular materials.

COB4: To help students study about materials in opthalmology

COB5: To make the students understand applications of various biomaterials

MODULE I BIOLOGICAL PERFORMANCE OF MATERIALS 9

Biocompatibility- Introduction to the biological environment – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – Host response: the inflammatory process - coagulation and hemolysis- approaches to thrombo- resistant materials development.

MODULE II ORTHOPAEDIC MATERIALS 9

Bone composition and properties - temporary fixation devices - joint replacement – Biomaterials used in bone and joint replacement: metals and alloys – Stainless steel, cobalt based alloys, titanium based materials – Ceramics: carbon, alumina, zirconia, bioactive calcium phosphates, bioglass and glass ceramics – polymers: PMMA, UHMWPE/HDPE, PTFE – Bone cement – Composites.

MODULE III CARDIOVASCULAR MATERIALS 9

Blood clotting – Blood rheology – Blood vessels – The heart – Aorta and valves – Geometry of blood circulation – The lungs - Vascular implants: vascular graft, cardiac valve prostheses, cardiac pacemakers – Blood substitutes – Extracorporeal blood circulation devices.
probability-internal conversion- nuclear isomerism.

MODULE IV DENTAL MATERIALS 9

Teeth composition and mechanical properties – Impression materials – Bases, liners and varnishes for cavities – Fillings and restoration materials – Materials for oral and maxillofacial surgery – Dental cements and dental amalgams –

Dental adhesives.

MODULE V MATERIALS IN OPTHALMOLOGY 9

Biomaterials in ophthalmology – Viscoelastic solutions, contact lenses, intraocular lens materials – Tissue grafts – Skin grafts – Connective tissue grafts – Suture materials – Tissue adhesives – Drug delivery: methods and materials – Selection, performance and adhesion of polymeric encapsulants for implantable sensors- biomemtic materials-Technology from nature.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Sujata V. Bhat. Biomaterials, Narosa Publication House, New Delhi, 2002.
2. Jonathn Black. Biological Performance of Materials: Fundamentals of biocompatibility, Marcel Dekker Inc, New York, 1992.
3. D.F.Williams (editor). Materials Science and Technology: A comprehensive treatment, Volume 14. Medical and Dental Materials, VCH Publishers Inc, New York, 1992.
4. F.Silver and C.Doillon. Biocompatibility: Interactions of Biological and implantable materials. Volume I Polymers, VCH Publishers Inc, New York, 1989.
5. L.L.Hench and E.C.Ethridge. Biomaterials: An Interfacial Approach, Academic Press, 1982.
6. Joon Park, R. S. Lakes, Biomaterials. An Introduction, Springer, third edition, 2010. Springer

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1: importance and properties of biomaterial..

CO2: different classes of orthopaedic materials

CO3: different types of cardiovascular materials.

CO4: various types of materials used in ophthalmology.

CO5: applications of various biomaterials

Board of Studies (BoS) :	**Academic Council:**
BOS of Physics was held on	19th AC held on 29.09.2022

30.6.22

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 704	BIOMEDICAL INSTRUMENTATION	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To understand the human physiological systems.

COB2: To know the different aspects of biosignal acquisition.

COB3: To understand the basics in biopotential recorders.

COB4: To know the importance methods, instruments available for biomedical field.

COB5: To analyze the special biomedical instrumentation systems.

MODULE I HUMAN PHYSIOLOGICAL SYSTEMS 9

Cells and their structure – Nature of Cancer cells – Transport of ions through the cell membrane – Resting and action potentials – Bio-electric potentials – Nerve tissues and organs – Different systems of human body. Biopotential Electrodes and Transducers Design of Medical instruments – components of the biomedical instrument system – Electrodes – Transducers.

MODULE II BIOSIGNAL ACQUISITION 9

Physiological signal amplifiers – Isolation amplifiers – Medical preamplifier design – Bridge amplifiers – Line driving amplifier – Current amplifier – Chopper amplifier – Biosignal analysis – Signal recovery and data acquisition – Drift Compensation in operational amplifier – Pattern recognition – Physiological Assist Devices. Pacemakers – Pacemakers batteries – Artificial heart valves – Defibrillators – nerve and muscle stimulators Heart – Lung machine – Kidney machine.

MODULE III BIOPOTENTIAL RECORDERS 9

Characteristics of the recording system – Electrocardiography (ECG) – Electroencephalography (EEG) – Electromyography (EMG) – Electroethinogrphy (ERG) and Electroculography (EOG) – Recorders with high accuracy – recorders for OFF line analysis.

MODULE IV OPERATION THEATRE EQUIPMENT 9

urgical diathermy- shortwave diathermy – Microwave diathermy – Ultrasonic disathermy – Therapeutic effect of heat – Range and area of irritation of different techniques – Ventilators – Anesthesia machine – Blood flowmeter –

Cardiac Output measurements – Pulmonary function analyzers – Gas analyzers – Blood gas analyzers – Oximeters – Elements of intensive care monitoring.

MODULE V SPECIALISED MEDICAL EQUIPMENTS 9

Blood Cell counter – Electron microscope – Radiation detectors – Photometers and colorimeters – digital thermometer – audiometers – X-rays tube – X-ray machine – image intensifiers – Angiography – Application of X-ray examination. Safety instrumentation: Radiation safety instrumentation – Physiological effects due to 50Hz current passage – Microshock and macroshock – electrical accident Hospitals – Devices to protect against electrical hazards – Hospitals architecture.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Arumugam M., Biomedical Instrumentation, Anurada Agencies Publishers, 1992.
2. Khandpur R.S., Handbook of Biomedical Instrumentation, Third Edition, Tata McGraw-Hill Education, 2014.
3. Shakti Chatterjee and Aubert Miller, Biomedical Instrumentation Systems, Cengage Learning Publisher, 2010.
4. Gromwell L., Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Second Edition, Prentice Hall, 1980.

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1: the human physiological systems.

CO2: the different aspects of biosignal acquisition.

CO3: different biopotential recorders such as EEG, ECG, EMG, EOG

CO4: biomedical instruments involved in advanced operation theatres

CO5: the application of biomaterials towards specialized medical equipment such as electron microscope and radiation detectors

Board of Studies (BoS) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 705	BIOPHOTONICS	L	T	P	C
SDG: 4		3	0	0	3

COURSE OBJECTIVES:

COB1: To know the role of light and its interaction in the cells and tissues.

COB2: To understand the different imaging techniques for the biological systems.

COB3: To know the concepts of spectroscopy in biological applications.

COB4: To understand the optical force spectroscopy.

COB5: To understand the role of Biophotonic materials in applications.

MODULE I INTERACTION OF LIGHT WITH BIOLOGICAL SYSTEMS 9

Interaction of light with cells, tissues, nonlinear optical processes with intense laser beams, photo-induced effects in biological systems.

MODULE II IMAGING TECHNIQUES 9

Imaging techniques: Light microscopy, wide-field, laser scanning - confocal, multiphoton, fluorescence lifetime imaging, FRET imaging - Frequency-Domain lifetime imaging. Cellular Imaging - Imaging of soft and hard tissues and other biological structures.

MODULE III SINGLE MOLECULE SPECTROSCOPY 9

Single molecule spectroscopy: UV-VIS spectroscopy of biological systems, single molecule spectra and characteristics – IR and Raman spectroscopy and Surface Enhanced Raman Spectroscopy for single molecule applications.

MODULE IV OPTICAL FORCE SPECTROSCOPY 9

Optical Force Spectroscopy: Generation optical forces – Optical trapping and manipulation of single molecules and cells in optical confinement - Laser trapping and dissection for biological systems - single molecule biophysics, DNA protein interactions.

MODULE V BIOSENSORS 9

Biosensors, Principles- DNA based biosensors – Protein based biosensors– materials for biosensor applications- fabrication of biosensors.

L – 45; TOTAL HOURS –45

REFERENCES:

1. Prasad. P.N., Introduction to Biophotonics, John Wiley & Sons, 2003

2. Michael P. Sheetz, Laser Tweezers in Cell Biology (Methods in Cell Biology), Vol.55, Academic Press Publishers, 1997.

3. Ranier .W, Nanoelectronics and Information Technology, Wiley Publishers, 2012.

4. Drexler. K.E., Nanosystems: Molecular Machinery, Manufacturing and Computation, Wiley Publishers, 1992.

COURSE OUTCOMES:

At the end of the course, the students will be able to

CO1: Make clear insights into the applications of light interaction with biological systems.

CO2: Compare different imaging techniques

CO3: Understand and analyse the various spectroscopic techniques used in biological system.

CO4: Effectively grasp the usage of the optical force spectroscopy.

CO5: Get clear ideas and communicate about the importance of use of spectroscopy in design of bio-photonic devices.

Board of Studies (BoS) :
BOS of Physics was held on 30.6.22

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	M	M	L	L	L	M	M	M	M	M
CO2	H	M	M	L	L	M	L	L	L	L	L	M	M	M	M
CO3	H	M	M	L	L	L	L	L	L	L	L	M	M	M	M
CO4	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M
CO5	H	M	M	L	M	M	M	L	L	L	M	M	M	M	M

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 4 : Ensuring inclusive and equitable quality education for all persons and promote lifelong learning opportunities.

Statement : The modules and topics mentioned in this course are designed to ensure all inclusive and thorough education with equity to all persons and promote learning opportunities at all times.

OEEY 706	DATA SCIENCE AND MACHINE LEARNING	L	T	P	C
SDG: 8		3	0	0	3

COURSE OBJECTIVES:

CO1: To understand the needs of machine learning in Real Time.

CO2: To acquire knowledge about the data science in machine learning.

CO3: To study the Monte Carlo Sampling and processing.

CO4: To explore knowledge about real-time data analysis using various models.

CO5: To understand the deep learning.

MODULE I INTRODUCTION 9

Introduction to Artificial Intelligence - Machine Learning – Types of Machine Learning - Data preprocessing - Noise Removal - Data Transformation - Normalization - Importing, Summarizingand Visualizing Data – Statistics-Visualizing Data-Plotting Qualitative Variables and Quantitative Variables- Data Visualization in a Bivariate Setting

MODULE II MACHINE LEARNING ALGORITHMS 9

Introduction to Supervised and Unsupervised Learning-Linear Regression - Single Variable – Multivariate –Logistic - Naive Bayes - Decision Tree - Neural Network - Single Layer Perceptron - Multilayer BPN- Training and Test Loss-Statistical Learning-Estimating Risk-Modeling Data-Multivariate Normal Models-Bayesian Learning

MODULE III SAMPLING AND UNSUPERVISED LEARNING 9

Unsupervised Learning Algorithm -Clustering - Monte Carlo Sampling-Resampling-Markov Chain Monte Carlo-Monte Carlo Estimation-Monte Carlo for Optimization-Simulated Annealing – Cross-Entropy Method-Splitting for Optimization -Noisy Optimization-Risk and Loss in Unsupervised Learning – Expectation-Maximization (EM) Algorithm-EM Algorithm for Mixture Models-K-Means – KNN - Hierarchical

MODULE IV REGRESSION ANALYSIS AND REGULARIZATION 9

Linear Regression-Analysis via Linear Models-Model Selection and Prediction – Cross-Validation and Predictive Residual Sum of Squares-In-Sample Risk and Akaike Information Criterion-Inference for Normal Linear Models -Nonlinear Regression Models-Modeling Regularization-Reproducing Kernel Hilbert Spaces- Smoothing Cubic Splines- Gaussian Process Regression - Graphical Models - Bayesian Networks

MODULE V ADVANCED LEARNING 9

Semi-supervisory Learning - Reinforcement Learning Algorithm – Feed-Forward Neural Networks -Back-Propagation – QLearning-Methods for Training- Steepest Descent- Levenberg–Marquardt Method - Limited-Memory BFGS Method- Adaptive Gradient Methods-Simple Polynomial Regression -Image Classification

L – 45 ; TOTAL HOURS – 45

REFERENCES:

1. Alex Smola, S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press, 2008.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Second Edition, Chapman & Hall/CRC, 2014.
3. Kroese, Dirk P., et al. Data science and machine learning: mathematical and statistical methods. Chapman and Hall/CRC, 2019.

COURSE OUTCOMES:

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

CO1: pre process the data

CO2: identify the suitable machine learning algorithm and apply the same to solve the given problem.

CO3: explain risk analysis and optimization algorithms.

CO4: apply the suitable regression method and regularization of data.

CO5: explore the applications of advanced learning.

Board of Studies (BoS): 17th BoS of IT held on 28.02.2023

Academic Council: 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5
CO1	M	L			L
CO2	M	L		M	
CO3	L	L	L		L
CO4	M	L	L	H	
CO5	L	H	L		H

Note: L - Low Correlation M -Medium Correlation H -High Correlation

SDG 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work.

Statement: The Learning algorithms helps to design and develop solutions for solving real world application in any engineering domain.

OEEY 707	ELECTRIC VEHICLE AND BATTERY STORAGE TECHNOLOGY	L	T	P	C
SDG:8,9		3	0	0	3

COURSE OBJECTIVES:

COB 1: To study the concept of electric vehicles

COB2: To get familiarized with EV and PHEV Energy Storage Systems

COB3: To learn the basics of various electric drive trains

COB4: To study about sensors and electric vehicle control

COB5: To study about electric vehicle and its environmental impact.

MODULE I INTRODUCTION TO ELECTRIC VEHICLE (EV) 9

A Brief History -Technology, benefits and challenges in comparison with IC engine - EV classification and electrification levels - degree of hybridization - Concept of Hybrid Electric Vehicle (HEV) – Working Principle of an HEV drive train - concept of electric, hybrid electric and plug-in hybrid electric vehicles – HEV drive train topologies - plug-in HEV drive train topologies.

MODULE II EV AND PHEV ENERGY STORAGE SYSTEMS 8

Battery parameters - Types of Battery : Lithium – Nickel – Sodium – Zinc – Lead Acid - Coin cell - Rechargeable Battery sealing – Ideal model, Linear model, Thevenin model – Battery Cell Voltage Equalization – Onboard power electronics battery management – Equalizer chaining method. Electrical Modeling of Ultra capacitors, Flywheel Energy Storage Systems and Renewable Fuel Cell Power Sources.

MODULE III FUEL CELL AND HYBRID ELECTRIC VEHICLE DRIVE TRAIN 10

Component Stage Based Efficiency Analysis of Series and Parallel HEV Drive Trains - Varied Driving Patterns and Regenerative Braking Efficiency Analysis - Overall Electric Drive Train Efficiency Analysis - Fuel Cell HEV: Modeling and Control - Power Electronics Interface of Fuel Cell and Traction System - Concept of Fuel Cell Plug-in HEV (FC-PHEV).

MODULE IV SENSORS AND VEHICLE CONTROL 11

Introduction, Basic Sensor Arrangement, Types of Sensors, Oxygen Sensor, Cranking Sensor, Position Sensor, Engine Oil Pressure Sensor, Linear and Angle Sensor, Flow Sensor, Temperature and Humidity Sensor, Gas Sensor, Speed and Acceleration Sensor, Knock Sensor, Torque Sensor, Yaw Rate Sensors, Tire Pressure Sensor,

Actuators.

Protocols: In vehicle Networking (IVN) - Local Interconnect Network(LIN) – Control Area Network (CAN) – Media Oriented System Transport (MOST) and FlexRay - Wireless Access in Vehicular Environment (WAVE).

MODULE V ENVIRONMENTAL IMPACT AND ENERGY MANAGEMENT 6

Vehicle pollution in context - alternative and sustainable energy used via the grid hybridization - V2G, G2V, V2B, V2H - energy consumption in braking and regeneration - brake system of EVs and HEVs.

L – 45; TOTAL HOURS:45

TEXT BOOKS:

1. Sheldon S. Williamson, “Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles”, Springer, 2013.
2. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2nd edition, 2015.
3. M. Ehsani, Y. Gao, Stefano Lango, K.M.Ebrahimi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 3rd Edition,2018.

REFERENCES:

1. Tariq Muneer and Irene Illescas García, “The automobile, In Electric Vehicles: Prospects and Challenges”, Elsevier, 2017.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition, CRC Press, 2016.
3. Tom Denton, “Electric and Hybrid Vehicles” Routledge Publishers, 1st edition, March 2016.

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

CO1: identify the opportunities and challenges of advances in electric vehicles

CO2 : model battery system for any EV

CO3: model and choose a suitable drive scheme suitable for developing an EV

CO4: compute the performance parameter of sensors, actuators and to apply suitable technique for automotive communication

CO5: choose proper energy consumption method to integrate with grid

Board of Studies (BoS) : **Academic Council:**

18th BoS of EEE held on 10.02.2023 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO 1	PSO 2
CO1	L	H	L	L	M	L	L	H	L	M	M	L	H	L
CO2	H	L	L	L	L	L	H	L	L	L	L	L	L	H
CO3	L	H	M	L	M	L	L	L	M	L	M	L	M	M
CO4	M	L	H	L	L	L	M	L	H	L	L	H	L	L
CO5	L	L	L	L	H	L	L	L	L	L	H	L	L	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas to promote economic growth.

SDG No. 9 Industry, innovation and infrastructure

Statement:

The development of zero emission electric vehicles will meet out the desired needs such as new innovative systems for industry and establishing advanced infrastructure.

OEEY 708	GREEN BUILDING AND ENERGY	L	T	P	C
SDG: 11	MANAGEMENT	3	0	0	3

COURSE OBJECTIVES:

The objectives of the course are to impart knowledge on

COB1: the concept of green design

COB2: the basics of green design strategies

COB3: the elements of green building

COB4: the concept of green building materials

COB5: the concept of energy management.

MODULE I BASIC CONCEPTS 8

Green Design concepts and definitions - sustainability begins with climate - recent upsurge in the green building movement -incentives for building green - incentives and tax deductions-green building programs -defining sustainable communities-emerging directions- liability - spectacular landmarks

MODULE II DESIGN STRATEGIES 9

Conventional versus Green Delivery Systems- green design strategies- The Integrated Design Process (IDP) -the green-building project delivery process- the integrated multidisciplinary project team - design process for high-performance buildings -sustainable site selection-general considerations- site selection - development density and community connectivity –brown field redevelopment - alternative transportation -site development storm water design-heat-island effect - light-pollution reduction

MODULE III ELEMENTS OF GREEN BUILDING 9

Introduction to Green Building- Energy- Water- Materials and Resources - Sustainable Sites and Land Use - Indoor Environmental Quality- Life Cycle Assessment- Energy, water and materials efficiency- Commissioning process – fundamental commissioning –retro commissioning -enhanced commissioning

MODULE IV GREEN COMPOSITES FOR BUILDINGS 9

Concepts of Green Composites-low-emitting materials -adhesives, finishes, and sealants -paints and coatings- flooring systems- earthen building materials- building reuse -materials reuse- construction waste management-recycled materials regional materials- rapidly renewable materials- bamboo-cork - insulation- linoleum

straw-bale construction-wheat board - use and selection of green office equipment -certified wood- life-cycle assessment of building materials and products

MODULE V ENERGY MANAGEMENT 10

Energy Management – Definitions and significance – objectives – Characterising of energy usage – Energy Management program – Energy strategies and energy planning Energy Audit – Types and Procedure – Optimum performance of existing facilities – Energy management control systems- Low Energy Approaches to Water Management. Management of Solid Wastes.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. Osman Attmann., “Green Architecture Advanced Technologies and Materials”, McGraw Hill, 2010.
2. Charles Kibert, J., “Sustainable Construction: Green Building Design and Delivery”, 2nd Edition, John Wiley and sons, 2007.
3. Moncef Krarti, “Energy Audit of Building Systems: an Engineering approach” CRC Press, LLC, Florida 2000.
4. “Alternative Building Materials and Technologies”. K.S.Jagadish, B.U. Venkataramareddy and K. S. Nanjundarao New Age International, 2007.

REFERENCES:

1. Doty S. and W. C. Turner, “Energy Management Hand book”, Fairmont Press, 2009.
2. LEED - Practices, Certification and Accreditation Handbook”. Sam Kubba, Butterworth-Heinemann, 2009.

COURSE OUTCOMES:

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

CO1: describe the basics of green design concept.

CO2: explain the concepts of green design strategies.

CO3: illustrate the elements of green building.

CO4: summarize the different green building materials.

CO5: describe the concept of energy management.

Board of Studies (BoS) : Academic Council:

17th BOS of CE held on 10.08.2022 20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	L	-	-	L	H	-	-	-	-	-	L	-	M
CO2	-	-	L	-	-	L	H	-	-	-	-	L	L	-	M
CO3	-	-	L	-	-	L	H	-	-	-	-	-	L	-	M
CO4	-	-	M	-	-	L	H	-	-	-	-	L	L	-	M
CO5	-	-	L	-	-	M	H	-	-	-	-	-	L	-	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Statement : The understanding of basics of green concepts, materials, energy management and leads to the development of sustainable building

OEEY 709	INDUSTRY 4.0 AND APPLICATIONS	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To describe the concepts, trends and the paradigm of Industry 4.0

COB2:To analyze the IoT technologies for practical IoT applications

COB3: To develop the ability to use Internet of Things related protocols and connectivity methods

COB4:. To elaborate the business issues in Industry 4.0.

COB5: To select the appropriate design concepts of Industrial IoT systems for various application

PREREQUISITES: Basic concepts in automation

MODULE I INTRODUCTION TO INDUSTRY 4.0 9

The Various Industrial Revolutions, Digitalization and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, The Journey so far: Developments in USA, Europe, China and other countries, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

MODULE II ROAD TO INDUSTRY 4.0 & RELATED DISCIPLINES 9

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics, Cyber physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Support System for Industry 4.0, Cyber Security.

MODULE III DATA INFORMATION AND COLLABORATION 9

Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0

MODULE IV BUSINESS ISSUES IN INDUSTRY 4.0 9

Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

MODULE V INDUSTRY 4.0 APPLICATIONS 9

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

L – 45 ; TOTAL HOURS – 45

TEXT BOOKS:

1. Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing the Digital Transformation”, Springer, 2017.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things" A press, 2017.
3. Deepak Gupta, Victor Hugo C. de Albuquerque, Ashish Khanna, Purnima Lala Mehta, "Smart Sensors for Industrial Internet of Things: Challenges, Solutions and Applications", Springer, 1st Edition, 2021.
4. Francis daCosta, “Rethinking the Internet of things: A Scalable Approach to Connecting Everything”, Apress, 2014.

REFERENCES:

1. Christoph Jan Bartodziej, "The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics", Springer, 2016.
2. Gary Smart, "Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, Web Sockets, and Python 3", Pckt Publishing, 2020

COURSE OUTCOMES:

On completion of the course, students will be able to

CO1: apply the basic concepts and principles of Industry 4.0

CO2:identify, formulate and solve engineering problems using Industrial IoT

CO3:describe basics of cloud computing with IoT capability

CO4:discuss the challenges of the industry through IoT techniques

CO5:develop a domain specific IoT system

Board of Studies (BoS) : 24th BOS of ECE held on 08.02.2023.

Academic Council: 20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO1	PSO2	PSO3
CO1	H	H	M	M	L	L	L	L	L	L	L	L	H	H	H
CO2	M	H	M	M	L	L	L	L	L	L	L	L	H	H	H
CO3	M	M	L	M	L	L	L	L	L	L	L	L	H	H	H
CO4	H	M	M	M	L	L	L	L	L	L	L	L	H	H	H
CO5	H	H	M	M	L	L	L	L	L	L	L	L	H	H	H

Note: L- Low Correlation M -Medium Correlation H -High Correlation

SDG 9 : Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation,

Statement: Able to apply the theoretical concepts for the various application in Industry 4.0

OEEY 710	NANOTECHNOLOGY AND CATALYSIS	L	T	P	C
SDG: 6,7,9,15		3	0	0	3

COURSE OBJECTIVES:

To make the student conversant with

COB1: basic knowledge on nanoscience and nanotechnology which includes the exotic properties of materials at nanoscale including various techniques for the processing of nanomaterials

COB2: various techniques available for the characterization of nanostructured materials

COB3: applications in selected fields and impacts of nanotechnology in ecosystem

COB4: Impart the basic concepts involved in catalytic processes.

COB5: Understand the importance of heterogeneous catalysis.

MODULE I INTRODUCTION AND PREPARATION OF NANOMATERIALS 9

Introduction to nanomaterials, Properties of nanomaterials, Nanostructures: Zero-, One-, Two- and Three-dimensional structures, Surface Plasmon Resonance, Change of bandgap; Methods of preparation of nanomaterials, top-down approach and bottom-up: Chemical precipitation and coprecipitation; Sol-gel synthesis; Ball milling synthesis; lithography, Plasma Laser deposition (PLD) techniques, Thermolysis routes (Solvothermal, Hydrothermal and pyrolysis), Microwave assisted synthesis; Sonochemical synthesis; Electrochemical synthesis.

MODULE II CHARACTERIZATION TECHNIQUES 9

Structural Characterization: X-ray diffraction, Scanning Electron Microscopy (SEM/HR-SEM/FE-SEM) with EDS, TEM (HR-TEM) and SAED analysis, Atomic force Microscopy (AFM). X-ray Photoelectron spectroscopy (XPS), Raman analysis. Introduction to advanced Scanning Probe Microscopy Techniques Scanning Tunnelling Mode (STM), Piezoelectric force microscopy (PFM). DLS and zeta potential analysis. BET surface area analysis, CHNSO micro analysis.

MODULE III APPLICATIONS AND ENVIRONMENTAL IMPACTS 9

Current applications - Short-term Applications - Long - term Applications – Energy filed - solar cells, military battle suits. Biomedical applications – Photodynamic therapy in targeted drugs - quantum dot technology in cancer treatment, MRI applications. Nanosensors: pH, heat, humidity, gas, toxic chemicals sensors and sensors for aerospace and defence – biosensors – water remediation - Environmental Impacts: toxicological health effects, relevant parameters in nanoparticles toxicology, integrated concept of risk assessment of nanoparticles.

MODULE IV CONCEPTS OF CATALYSIS 9

Acid-base catalysis – catalysis by transition metal ions and their complexes – supported transition metal complexes as catalysts – catalysis by enzymes – phase transfer catalysis - photocatalysis – adsorption – chemisorption on metals, metal oxides and semiconductors - kinetics of unimolecular and bimolecular surface reactions - Contact time - WHSV - time on stream - Catalyst deactivation and regeneration, TOF, TON.

MODULE V HETEROGENEOUS CATALYSTS 9

Metals, metal oxides, mixed metal oxides, supported metals, spinels, perovskites, super acids, hydrotalcites, zeolites and zeotypes (small, medium, large), shape selective catalysts, mesoporous materials (SBA, MCM, KIT, AlPOs, MOFs, COFs) Hydrothermal synthesis, sol-gel process, impregnation method, ion-exchange method - Operations in catalyst manufacture - drying, calcination, spray drying, Reactors- fixed bed and flow reactors.

L – 45; TOTAL HOURS – 45

REFERENCES:

1. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill, New Delhi, 2007.
2. G. Cao, Nanostructures and Nanomaterials –Synthesis, Properties and Applications, Imperial College Press, London, 2004.
3. C. N. R. Rao, A. Muller and A. K. Cheetham, The Chemistry of Nanomaterials, Volume 1, Wiley –VCH Verlag GmbH & Co. KgaA, Weinheim, 2004.
4. G. A. Ozin, A. C. Aresnault, L. Cadematriri, Nanochemistry: A chemical approach to nanomaterials, RSC Publishing, 2008
5. J. Rajaram and J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations, Macmillan Publishers India Limited, 2000.
6. B. Viswanathan, S. Sivasanker and A.V. Ramaswamy (Editors), Catalysis

COURSE OUTCOMES:

The students will be able to

CO1: differentiate the nanomaterials based on their dimensions and acquire knowledge of various synthetic methods

CO2: understand the components of instrumental techniques of and characterization techniques for structural and properties of nanomaterials

CO3: select the appropriate nanomaterials for specific applications in the interested arena

CO4: Find the fundamentals of catalysis

CO5: Evaluate significance of heterogeneous catalysts.

Board of Studies (BoS):
12th BoS of Chemistry held on 22.07.2022

Academic Council:
19th AC held on 29.09.2022

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		L		M	H	H									
CO2	M			H	M	H									
CO3					H	M									
CO4															
CO5															

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 6: Clean Water and Sanitation
SDG 7: Affordable & Clean Energy
SDG 9 : Industry and Innovation
SDG 15 : Life on Land
Statement:
SDG 6, 7 & 9: Foundation to work in R&D of renewable energy and sensors sector and for teaching career.
SDG 15: R&D labs in API labs in the production novel materials for various applications

OEEY 711	PROJECT MANAGEMENT	L	T	P	C
SDG: 9		3	0	0	3

COURSE OBJECTIVES:

COB1: To learn the concepts of organizational project management.

COB2: To acquire knowledge on leadership in project management.

COB3: To gain knowledge in stakeholder management and program management

COB4: To familiarize with the project scope and time management

COB5: To be conversant with project execution, monitoring and closing.

MODULE I INTRODUCTION – ORGANIZATIONAL PROJECT MANAGEMENT L:9

Introduction to Organizational Project Management- Organizational Project Management Framework- Project Linkages to Strategic Management - Relationships between Portfolio, Program, and Project Management - Organizational Issues and Project Management.

MODULE II PROJECT MANAGEMENT - LEADERSHIP L:9

Importance of Leadership in Project Management-Roles and Responsibilities of a Project Manager-Leadership vs. Management-Project Management Leader's Portfolio-Technical Management skills -Project Entrepreneurship skills- Project Leadership skills

MODULE III PROJECT STAKE HOLDER MANAGEMENT AND PROGRAM MANAGEMENT L:9

Project Stakeholder Management-Stakeholders Identification and Assessment - Stakeholders vs. Project Lifecycle - Stakeholders and Interested Parties- Program Management - Program Characteristics - Programs vs Projects - Programs vs Portfolios

MODULE IV PROJECT SCOPEAND TIME MANAGEMENT L:9

Project Scope: Planning, Defining, Verification and Change control -Project Activity sequencing -Precedence diagram method- Arrow diagram method – Project Activity Time Estimation -Tools for Activity Time Estimation -Schedule development – Resource levelling heuristics

MODULE V PROJECT EXECUTION,MONITORING AND L:9

CLOSING

Execution phase overview-Delegating tasks -Assessing project status - Foreseeing future challenges - Managing progress and timeline adjustments Project execution guidelines - Monitoring phase overview - Key Performance Indicators -Evaluating progress-Assessing work quality -Setting quality assurance procedures -Monitoring risks -Closing phase overview -Obstacles in the closing phase -Evaluating project performance-Final reports and managing records -Project closing guidelines

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Projects: Planning, Analysis, Financing, Implementation and Review,

   Prasanna Chandra, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
2. Jack. R. Meredith, Samuel. J. Mantel & Scott. M. Shafer, Project

   Management in Practice, Fifth Edition, Bangalore: Wiley, 2015

REFERENCES:

1. Project Management and Control, Narendra Singh, Himalaya Publishing, New Delhi, 2015.
2. Bob Hughes, Mike Cotterrel “Software Project Management”, Tata

   McGraw-Hill, 2009
3. A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition, Author& publisher - Project Management Institute 2017
4. Lean Project Management: Philip Small, Arkham Publishing Limited, March 2020

COURSE OUTCOMES:

After completion of the course, students should be able to

CO1:Explain the concepts of organizational project management

CO2: Discuss the leadership in project management.

CO3: Elucidate the stakeholder management and program management

CO4: Explain project scope and time management

CO5: Describe project execution, monitoring and closing

Board of Studies (BoS) :
21st BOS of Mechanical Engg. held on 10.02.2023.

Academic Council:
20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L		L	M		H							M	L
CO2	L		M	L		L							L	H
CO3	M		M	H		L							H	M
CO4	L		L	L		M							L	M
CO5	L		M	L		L							H	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The comprehensive understanding of Project management principles and techniques brings prosperity, create jobs, and build prosperous equitable societies across the country

OEEY 712	REAL TIME EMBEDDED SYSTEMS	L	T	P	C
SDG: 4,9		3	0	0	3

COURSE OBJECTIVES:

COB1: To define the fundamental concepts of real time systems

COB2: To analyze the various uniprocessor and multiprocessor scheduling mechanisms

COB3: To develop knowledge on programming languages and tools for real time systems.

COB4: To discuss the overview of real time data bases

COB5: To classify the fault tolerance and evaluation techniques in real time systems.

PREREQUISITES: Embedded Systems, Operating Systems

MODULE I INTRODUCTION : EMBEDDED SYSTEMS & REAL TIME SYSTEMS 9

Introduction –Embedded system - characterizing real time system -Performance Measures for Real Time Systems – Estimating Program Run Times – Task Assignment and Scheduling.

MODULE II PROGRAMMING LANGUAGES AND TOOLS 9

Desired language characteristics – ADA language - Data typing – Control structures – Facilitating Hierarchical Decomposition- Packages- Run time Error handling – Overloading and Generics – Multitasking – Timing Specifications – Programming Environments – Run time support.

MODULE III REAL TIME DATABASES 9

Basic Definition, Real time Vs General Purpose Databases- Main Memory Databases- Transaction priorities-Transaction Aborts-Concurrency control issues-Disk Scheduling Algorithms-Two – phase Approach to improve Predictability – Maintaining Serialization Consistency – Databases for Hard Real Time Systems.

MODULE IV REAL TIME COMMUNICATION 9

Communications media, Network Topologies, Protocols- contention based, Token based, Stop-and-Go multihop, Polled Bus, Hierarchical Round Robin Protocol, Deadline-Based Protocols, Fault Tolerant Routing.

MODULE V FAULT TOLERANT AND EVALUATION TECHNIQUES 9

Fault Tolerance Techniques – Fault Types – Fault Detection-Fault and Error containment- Redundancy- Reliability Evaluation Techniques – Software error models.

L –45 ; TOTAL HOURS –45

TEXT BOOKS:

1. C.M. Krishna, Kang G. Shin, “Real – Time Systems”, McGraw – Hill International Editions, 2010.
2. Rajib Mall,”Real-time systems: theory and practice”, Pearson Education, 2007.

REFERENCES:

1. Xiaocong Fan, “Real-Time Embedded Systems: Design Principles and Engineering Practices”, Elsevier, 2015.
2. Albert M. K. Cheng, “Real-Time Systems: Scheduling, Analysis, and Verification“, Wiley publishers, 2003.
3. P. A. Laplante," Real-Time Systems Design & Analysis", Willey, 2011.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.

COURSE OUTCOMES:

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

CO1: describe the characteristics of real time system.

CO2: apply scheduling algorithms based on the application.

CO3: discuss about the programming language characteristics and tools of real time systems.

CO4: choose the appropriate real time communication protocols.

CO5: analyze the fault tolerance and evaluation techniques in real time systems.

Board of Studies (BoS) :
24th BOS of ECE held on 08.02.2023.

Academic Council:
20th AC held on 13.04.2023

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO2	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO3	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO4	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H
CO5	H	H	H	H	H	H	M	M	M	M	M	M	H	H	H

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Statement: Understanding of the real time systems will bring practical knowledge on quality education.

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation

Statement: capable of promoting industrialization through the application of real-time system design principles.

OEEY 713	ROBOTIC TECHNOLOGY	L	T	P	C
SDG: 9		3	0	0	3

OBJECTIVES:

COB1: To study the basics of robotics technology.

COB2: To acquire knowledge about robot operating system.

COB3: To familiarize with robot assembly and aerial robots.

COB4: To learn about futuristic robots.

COB5: To know about the application of robots in various fields.

MODULE I INTRODUCTION L:6

Robot – Definition – Robot Anatomy – Co-ordinate Systems - Work envelope: Types and classification – Specifications – Pitch, Yaw, Roll, and Joint notations - Speed of motion - Pay load – Robot Parts and their functions – Need for robots.

MODULE II ROBOT OPERATING SYSTEM L:10

Master – Node – Topic – Messages – Subscriber – Publisher – Robot Operating System (ROS) packages – ROS file system – Services and actions – Custom publisher – Custom subscriber – ROS topic list and ROS topic information -ROS topic echo – ROS topic pub – Custom messages.

MODULE III ROBOT ASSEMBLY AND AERIAL ROBOTS L:12

Robotic assembly automation - Parts presentation methods - Assembly operations - Assembly system configurations - Design for robot assembly - Basics of aerial robots - Modelling and control of small Unmanned Aerial vehicles - Guidance and navigation of small range aerial robots.

MODULE IV FUTURE TECHNOLOGY L:9

Wheeled and legged Robot – Legged locomotion and balance – Arm movement, Gaze and auditory orientation control – Facial expression – Hands and manipulation – Sound and speech generation – Motion capture/Learning from demonstration.

MODULE V APPLICATIONS L:8

Implementation of Robots in Industries - Industrial application for material handling: machine loading and unloading, assembly, and inspection– Applications of robot in Arc welding, Spot welding, and Spray painting - Robots

in Assembly operation, Cleaning and underwater applications –Applications of Robots in Agriculture, Mining, Defense, Nuclear, Medical, and Space.

L – 45; TOTAL HOURS – 45

TEXTBOOKS:

1. Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning.,2009.
2. Richard D. Klafter, Thomas. A, ChriElewski, Michael Negin, “Robotics Engineering an Integrated Approach”, Phi Learning.,2009
3. YoonSeokPyo, HanCheol Cho, RyuWoon Jung, TaeHoon Lim, ROS Robot Programming.
4. M.P.Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw Hill, 2001.

REFERENCES:

1. Bernard Hodges, “Industrial Robotics”, Second Edition, Jaico Publishing house, 1993.
2. Tsuneo Yohikwa, “Foundations of Robotics Analysis and Control”, MIT Press., 2003.
3. John J. Craig, “Introduction to Robotics Mechanics and Control”, Third Edition, Pearson,2008.
4. Craig.J. J, “Introduction to Robotics Mechanics and Control”, Addison-Wesley, 1999.Robotics Lab manual, 2007.

COURSEOUTCOMES:

After completion of the course, students should be able to

CO1: Explain the basics of robots.

CO2: Elucidate robot operating system.

CO3: Discuss about robot assembly and aerial robots.

CO4: Describe the future robot technology.

CO5: Explain the applications of robots.

Board of Studies (BoS) :	**Academic Council:**
21st BOS of Mechanical Engg. held on 10.02.2023.	20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		M			M					L	L	H	M
CO2	M		M			M					L	L	H	M
CO3	M		M			M					L	L	H	M
CO4	M		M			M					L	L	H	M
CO5	M		M			M					L	L	H	M

Note: L - Low Correlation M - Medium Correlation H - High Correlation

SDG 9: Build resilient Infrastructure, promote inclusive and sustainable industrialization and foster innovation.

The holistic knowledge of robot technology, its operating system, and future robot helps in developing robots for various applications.

OEEY 714 SOFT COMPUTING TECHNIQUES L T P C
SDG:8,9 3 0 0 3

COURSE OBJECTIVES:

COB 1: To enumerate the strengths and weakness of soft computing
COB2 To focus on the basics of neural networks
COB3: To learn the basics of fuzzy systems and hybrid Neurofuzzy systems
COB4: To emphasize the role of evolutionary computing algorithms
COB5: To learn the ANN, FIS and GA tool boxes for various soft computing applications.

MODULE I BASICS OF SOFT COMPUTING 8

Soft computing – Hard Computing – Artificial Intelligence as the basis of soft computing – Relation with logic driven and statistical method driven approaches- Expert systems – Types of problems: Classification, Functional approximation, Optimizations – Modeling the problem – Machine Learning – Hazards of Soft Computing – Current and future areas of research.

MODULE II ARTIFICIAL NEURAL NETWORK 10

Artificial Neuron – Multilayer perceptron – Supervised learning – Back propagation network –Types of Artificial Neural Network: Supervised Vs Un Supervised Network – Radial basis function Network – Self Organizing Maps – Recurrent Network – Hopfield Neural Network – Adaptive Resonance Theory – Issues in Artificial Neural Network – Applications.

MODULE III FUZZY SYSTEMS 10

Fuzzy Logic – Membership functions – Operators – Fuzzy Inference systems – Other sets: Rough sets, Vague Sets – Fuzzy controllers - Cooperative Neuro fuzzy systems – Neural network driven fuzzy reasoning – Hybrid Neuro fuzzy systems – Construction of Neuro Fuzzy systems: Structure Identification phase, Parameter learning phase – Applications.

MODULE IV EVOLUTIONARY COMPUTING & ALGORITHMS 7

Overview of evolutionary computing – Genetic Algorithms and optimization – Genetic Algorithm operators – Genetic algorithms with Neural/Fuzzy systems – Variants of Genetic Algorithms– Population based incremental learning – Meta heuristic algorithms - Evolutionary strategies and applications.

MODULE V MATLAB TOOL BOX FOR SOFT COMPUTING 10

Artificial Neural Network (ANN) Toolbox - training and testing with different activation

functions- controller design using ANN toolbox Fuzzy Inference System (FIS) Editor and tool box- fuzzy controller design - Genetic Algorithm Toolbox - Application of ANN, FIS and GA tool box to various power system and control applications.

L – 45; TOTAL HOURS – 45

TEXT BOOK:

1. Samir Roy, “Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms”, Pearson, 2013

REFERENCES:

1. Anupam Shukla, Ritu Tiwari and Rahul Kala, “Real life applications of Soft Computing”, CRC press, 2010.
2. Fakhreddine O. Karray, “Soft Computing and Intelligent Systems Design: Theory, Tools and Applications”, Pearson, 2009
3. Matlab Simulink Manual

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

CO1: enumerate the theoretical basis of soft computing

CO2 : explain the Neural network architecture and different learning rules

CO3: apply the fuzzy systems and hybrid Neurofuzzy systems

CO4: demonstrate the different evolutionary and metaheuristic algorithms

CO5: demonstrate the most appropriate soft computing technique for a given situation using MATLAB tool box.

Board of Studies (BoS) :
18th BoS of EEE held on 10.02.2023

Academic Council:
20th AC held on 13.04.2023

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO1 1	PO 12	PSO 1	PSO 2
CO1	L	H	L	L	M	L	L	H	L	M	M	L	H	L
CO2	H	L	L	L	L	L	H	L	L	L	L	L	L	H
CO3	L	H	M	L	M	L	L	L	M	L	M	L	M	M
CO4	M	L	H	L	L	L	M	L	H	L	L	H	L	L
CO5	L	L	L	L	H	L	L	L	L	L	H	L	L	M

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 8: Decent work and economic growth

Statement: The learners of this course can get decent work and earn financial benefits and they can work in interdisciplinary areas to promote economic growth.

SDG No. 9 Industry, innovation and infrastructure

Statement:

The development of soft computing techniques will meet out the desired needs such as new innovative systems for industry and establishing advanced infrastructure.

OEEY 715	STRUCTURAL INTERPRETATION OF	L	T	P	C
SDG: 4, 9	MATERIALS	3	0	0	3

COURSE OBJECTIVES:

To use the concepts (basic and advanced level) of analytical methods for structure elucidation of materials and the students will be trained for the

COB1: Interpretation of electronic spectral data of materials

COB2: Interpretation of magnetic spectral data of materials

COB3: Interpretation of structural and morphological data of materials

COB4: Interpretation of thermoanalytical data of materials

COB5: Interpretation of electrochemical and XPS data of materials

MODULE I ELECTRONIC DATA 9

UV-visible, fluorescence and phosphorescence: Characteristic absorption of simple chromophoric groups, conjugated/ aromatic/ ligand systems, metal complexes and materials. FT-IR and Raman: Characteristic group frequencies of organic, inorganic molecules and various materials (polymer, nano, semiconducting) Interpretation of organic and inorganic and hybrid materials using combination of the spectral data.

MODULE II MAGNETIC AND MASS DATA 9

Solid-state nuclear magnetic resonance spectroscopy: Compounds containing ^{1}H, ^{13}C, ^{19}F,^{27}Al, ^{29}Si, and ^{31}P nuclei. Electron spin resonance (ESR): Simulation of ESR spectra of paramagnetic species, spin dynamics in solid and liquid. Mass spectrometry: The production and analysis of positive ions, molecular ions, application of isotopic abundance measurements, fragmentation modes and rearrangement of ions. Interpretation of organic, inorganic compounds and materials using combination of the spectral data.

MODULE III STRUCTURAL AND MORPHOLOGICAL DATA 9

Fundamental theoretical framework for diffraction (XRD) and imaging methods (SEM, TEM and AFM) used in structural and compositional characterization of materials in solid, film state etc.

MODULE IV THERMOANALYTICAL DATA AND SURFACE AREA 9

Interpretation of Differential Thermal Analysis (DTA), Thermo-gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC) data of various materials including inorganic complex, organic polymeric materials, composite, nano-composites etc; Surface area analysis; isotherms, types, BET surface area, pore dimensions, pore volume, etc.

MODULE V ELECTROCHEMICAL AND XPS DATA 9

Cyclic voltammetry for oxidation and reduction potentials, TAFEL polarization and Impedance

spectroscopy for corrosion inhibitor behavior, chronoamperometry for charge or discharge of battery. X-ray photoelectron spectroscopy: Study the chemical composition and oxidation state of elements at the surface and interface. Applications of XPS in various arenas.

L – 45; TOTAL HOURS – 45

TEXT BOOKS:

1. R. S. Drago, Physical Methods for Chemists, W. B. Saunders,1992.
2. R. M. Silverstein, C. G. Bassler and T. C. Morril, Spectrophotometric Identification of Organic Compounds, 5th edition, Wiley, 1991.
3. D. H. Williams and I. Fleming, Spectroscopic Methods in Organic Chemistry, 3rd edition, McGraw Hill, 1980.
4. W. Kemp, Organic Spectroscopy, ELBS, 1979.
5. W. L. Jolly, The synthesis and characterization of inorganic compounds, Prentice-Hall, 1970.
6. John Wertz, Electron Spin Resonance: Elementary Theory and Practical Applications, Springer Science & Business Media, 2012.
7. R. F. Speyer, Thermal Analysis of Materials, CRC Press, 1994.
8. P.J. Goodhew, J. Humphreys and R. Beanland, Electron Microscopy and Analysis, Taylor & Francis, 2001.
9. John F Watts, John Woistenhoime, An introduction to surface analysis by XPS and AES, John Wiley and Sons, 2nd edition, 2003.
10. James, B. Condon, Surface Area and Porosity Determinations by Physisorption Measurement and Theory, Elsevier, 1st edition, 2006.

COURSE OUTCOMES:

The students will be able to

CO1: Interpret electronic spectral data of materials

CO2: Interpret magnetic spectral data of materials

CO3: Interpret structural and morphological data of materials

CO4: Interpret thermo analytical data and porous nature of materials

CO5: Interpret electrochemical and XPS data of materials

Board of Studies (BoS):
12th BoS of Chemistry held on 2207.2022

Academic Council:
19th AC held on 29.09.2022

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	H	M		H	M	H									
CO2	H	M		H	M	L									
CO3	H	L		H	M	M									
CO4	H	L		H	M	H									
CO5	H	L		H	M	L									

Note: L- Low Correlation M - Medium Correlation H -High Correlation

SDG 4: Quality Education
SDG 9: Industry and Innovation

Statement:
SDG9: Foundation to work in R&D laboratory, chemical industry, independent researcher and for teaching career.
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities.