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शिवाजी विद्यापीठ, कोल्हापूर ४१६ ००४, महाराष्ट्र
दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४. २६०९४८७
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Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SU/BOS/Sci & Tech/ 183 **Date: 10/06/2026**

The Principal / Director,
All Concerned Affiliated Colleges / Institutions,
Shivaji University, Kolhapur.

Subject: Regarding revised syllabus of **B. Tech.** degree **Programme (Affiliated Colleges)** under the Faculty of Science and Technology as per NEP 2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, Nature of Question paper and equivalence of B. Tech. degree programme under the Faculty of Science & Technology as per National Education Policy 2020 (NEP 2020).

Sr. No.	B. Tech Course Syllabus	
1	Civil Engineering	Part-III
2	Mechanical Engineering	Part-III
3	Mechanical and Mechatronic Engineering (Additive Manufacturing)	Part-III
4	Electrical Engineering	Part-III
5	Electrical and Computer Engineering	Part-III
6	Electronics and Telecommunication Engineering	Part-III
7	Electronics & Computer Science Engineering	Part-III
8	Computer Science and Engineering	Part-III
9	Computer Science and Engineering (Artificial Intelligence & Machine Learning) (AIML)	Part-III
10	Computer Science and Engineering (Data Science) (DS)	Part-III
11	Computer Science and Engineering (Artificial Intelligence & Data Science) (AIDS)	Part-III
12	Electronics and communication Engineering (Bio-Medical Engineering)	Part-II

This Syllabus, nature of question and equivalence shall be implemented from the academic year **2026-27** onwards. A soft copy containing the syllabus is attached herewith and it is available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP-2020.**

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October/ November 2026 & March / April 2027. These chances are available for repeater students, if any

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy. Registrar

Copy to: for Information and necessary action

1	The I/c Dean, Faculty of Science & Technology	7	Appointment A & B Section
2	Director, Board of Examinations & Evaluation	8	Affiliation (T.1) (T.2) Section
3	The Chairperson, Respective Board of Studies	9	P.G.Admission Section,
4	Other Exam 4 Section,	10	P.G Seminar Section
5	Eligibility Section,	11	Computer Centre/ IT Cell
6	Internal Quality Assurance Cell (IQAC)		

Shivaji University Kolhapur

Revised Syllabus as per
National Education Policy -2020

T. Y. B. Tech.
Electrical Engineering

To be implemented from

Academic Year 2026-27

SHIVAJI UNIVERSITY, KOLHAPUR

NANE OF FACULTY: SCIENCE AND TECHNOLOGY

PROGRAMME NAME AND CODE: ELECTRICAL ENGINEERING

PART: THREE

Preamble

The Third Year B. Tech. Electrical Engineering Curriculum of Shivaji University is designed to equip students with strong theoretical knowledge, practical skills, and emerging technological competencies required in modern industries and research environments. The curriculum emphasizes the integration of core Electrical Engineering concepts with advanced technologies such as Smart Grids, Renewable Energy Systems, Power Electronics, Industrial Automation, Artificial Intelligence (AI), Internet of Things (IoT), and intelligent control techniques to meet the evolving demands of Industry 4.0.

The curriculum provides a balanced blend of power systems, electrical machines, control engineering, power electronics, electrical protection, energy conversion, and industrial applications. Courses such as Electrical Power Transmission and Distribution, Control Systems, AC Machines, Power Electronics, Advanced Control Systems, and Power System Analysis strengthen the students' analytical and problem-solving abilities while developing a solid engineering foundation. The laboratory courses and project work encourage experiential learning, hands-on practice, innovation, teamwork, and industry-oriented skill development.

Special emphasis has been given to multidisciplinary learning and emerging domains through programme electives and minor courses including Electrical Machines, Renewable Energy System, Power Electronics and Embedded System. These subjects prepare students to address real-world engineering challenges related to sustainability, automation, product reliability, smart manufacturing, energy efficiency, and predictive maintenance.

The inclusion of AI and ML applications across various subjects reflects the evolving needs of modern engineering industries. Students are introduced to data-driven approaches, intelligent monitoring systems, optimization techniques, and predictive analysis tools that enhance engineering decision-making and operational efficiency.

The curriculum also focuses on Outcome-Based Education (OBE), promoting critical thinking, creativity, communication skills, ethical values, and lifelong learning. Through laboratory work, industrial visits, assignments, mini-projects, students gain exposure to industrial practices and develop professional competencies required for higher studies, entrepreneurship, research, and employment in diverse sectors.

Overall, this syllabus aims to develop competent, innovative, and socially responsible Electrical engineers capable of contributing effectively to technological advancement, industrial growth, and sustainable development at national and global levels.

Program Learning Outcomes (PLOs) / Program Outcomes (POs)

1. **PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
2. **PO2: Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
3. **PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
4. **PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis and interpretation of data to provide valid conclusions. (WK8).
5. **PO5: Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
6. **PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
7. **PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national and international laws. (WK9)
8. **PO8: Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
9. **PO9: Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
10. **PO10: Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
11. **PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Program Educational Objectives (PEOs)

1. **Professional Competence and Career Growth**
   Graduates will apply fundamental knowledge of electrical engineering to solve real-world engineering problems and establish successful careers through professional employment, higher education, research, or entrepreneurship in core and allied fields.

2. **Lifelong Learning and Technological Adaptability**
   Graduates will engage in continuous learning and adapt to emerging technologies such as automation, artificial intelligence, and advanced manufacturing to meet evolving industrial and societal needs.

3. **Ethics, Leadership, and Social Responsibility**
   Graduates will demonstrate ethical practices, environmental awareness, leadership qualities, teamwork, and effective communication skills while contributing to sustainable development in multidisciplinary environments.

Eligibility for Admission-

Eligibility for F.Y. B.Tech.

(First Year - Engineering or Technology (4 years duration))

(1) Maharashtra State Candidature Candidate.-

The candidate,-

1. should be a citizen of India;

2. (ii) should have Passed 10+2 examination or its equivalent examination with Physics and Mathematics as compulsory subjects along with Chemistry or Biotechnology or Biology or Technical Vocational subject or Computer Science or Information Technology or Informatics Practices or Agriculture or Engineering Graphics or Business Studies or Electronics or Entrepreneurship and obtained at least forty five per cent marks (at least forty per cent marks, in case of Reserved categories, Economically Weaker Section and Persons with Disability candidates belonging to the Maharashtra State only) in the above subjects taken together and The Candidate should have appeared in all the subjects in PCM MHT-CET 2026 and obtained non zero score in PCM MHT-CET 2026 conducted by the Competent Authority; (There candidates are eligible to apply for all 29 major disciplines declared by AICTE)

Or

3. Should have passed 10+2 examination or its equivalent examination with Physics and Chemistry as compulsory subjects along with the Mathematics or Biotechnology or Biology or Technical Vocational subject or Computer Science or Information Technology or Informatics Practices or Agriculture or Engineering Graphics or Business Studies or Electronics or Entrepreneurship as one of the subject and obtained at least forty five per cent marks (at least forty per cent marks, in case of Reserved categories, Economically Weaker Section and Persons with Disability candidates belonging to the Maharashtra State only) in the above subjects taken together and the candidate should have appeared in all the subjects in MHT-CET 2025 and obtained non zero score in Physics, Chemistry and Biology (PCB) MHT-CET 2025 conducted by the Competent Authority is eligible for admission to any of the following Courses under major disciplines declared by concerned Appropriate Authority or All India Council for Technical Education (AICTE), namely:- (a)Agriculture Engineering;

(b)Biotechnology; (c)Food Engineering; (d)Leather Technology; (e)Packaging Technology; (f) Pharmaceutical Engineering; (g)Printing Engineering; (h)Fashion Technology; or (i) Textile Chemistry;

Or

4. Should have passed minimum three years Diploma in Engineering and Technology and obtained at least forty five per cent marks (at least forty per cent marks, in case of Reserved categories, Economically Weaker Section and Persons with Disability candidates belonging to the Maharashtra State only) ;

Or

5. Passed three years Diploma of Vocation (D. Voc.) stream in the same or allied sector;

Eligibility for Direct Second Year B.Tech.

(Direct Second Year (Lateral Entry)- Engineering /Technology (3 Years duration)

The candidate,-
should be a citizen of India;
should have passed minimum three years or two years (Lateral Entry) Diploma Course in Engineering and Technology with at least forty five per cent. marks (at least forty per cent. marks in case of Candidates of Reserved categories, Economically Weaker Section and Persons with Disability category belonging to Maharashtra State) in any branch of Engineering and Technology from an All India Council for Technical Education (AICTE) or Central Government or State Government approved Institution or its equivalent;

Or

should have passed B.Sc. Degree from a University Grants Commission (UGC) or Association of Indian Universities recognized University with at least forty five per cent. marks (at least forty per cent. marks in case of candidates of Reserved categories, Economically Weaker Section and Persons with Disability category belonging to Maharashtra State) and passed HSC or its equivalent examination with Mathematics as a subject;

Or

should have passed three years D. Voc. Stream in the same or allied sector;
and Any other eligibility criteria and requirement declared from time to time by the appropriate authority as defined under the Act.

STANDARD OF PASSING AND DETERMINATION OF SGPA/CGPA, GRADING AND DECLARATION OF RESULTS

Passing criteria:

1. Passing with 40% marks is mandatory in ESE theory. The duration of ESE theory examination will be 02:30 Hrs. For Engineering Graphics subject of F. Y. B. Tech, it will be of 03:00 Hrs. Combined passing marks (MSE+ISE/CA+ESE) for theory course are 40%.
2. MSE will be based on 50% syllabus from beginning (First Three Units).
3. No compulsory passing for MSE.
4. Compulsory passing percentage for ISE/CA of theory and practical is 40%.
5. Compulsory passing percentage for ESE practical / oral examination 40%.
6. Student should clear all first year passing heads before admits to third year and clear all second year passing heads before admits to fourth year.
7. Aggregate of a particular year (both the semesters) shall considered as a separate head of passing for the result of that concerned year and 45 % aggregate score is mandatory. The student not fulfilling this criterion can improve the score of 45% aggregate through appearing in re-examination for maximum of three theory courses.
8. If student fails to improve the score of 45% aggregate through appearing in re-examination then he/she can improve the score of 45% aggregate by re-appearing in subsequent concern odd semesters (3, 5, 7) or concern even semesters (4, 6, 8) ESE of theory course examination in next academic year.

The Semester Grade Point Average (SGPA) shall be calculated for each semester and Cumulative Grade Point Average (CGPA) shall be calculated at the end of all semesters.
The standard of passing shall be in accordance with the following table :

Marks Obtained	Numerical Grade (Grade Point)		CGPA	Letter Grade
Absent	0 (zero)		-	-
0 – 39	0 (zero)		0.0 – 4.99	F (Fail)
40 – 49	5		5.00 – 5.49	C
50 – 59	6		5.50 – 6.49	B
60 – 69	7		6.50 – 7.49	B+
70 – 79	8		7.50 – 8.49	A
80 – 89	9		8.50 – 9.49	A+
90 – 100	10		9.50 – 10.0	O (Outstanding)

Note :
The award of the final Grade for the degree of B. Tech. shall be calculated based on CGPA.

Calculation of SGPA and CGPA:

1. Semester Grade Point Average **(SGPA)**

$$\textbf{SGPA} = \frac{\sum(\text{Course credits} \times \text{Grade points obtained}) \text{ of a Semester}}{\sum(\text{Course credits}) \text{ of respective Semester}}$$

2. Cumulative Grade Point Average **(CGPA)**

$$\textbf{CGPA} = \frac{\sum(\text{Total credits of a Semester} \times \text{SGPA of respective Semester}) \text{ of all Semesters}}{\sum(\text{Total course credits}) \text{ of all Semesters}}$$

1. Marks obtained > = 0.5 shall be rounded off to next higher digit.
2. The SGPA & CGPA shall be rounded off to 2 decimal points.
3. CGPA will be calculated cumulatively from Sem. I to Sem. VIII for regular students and from Sem. III to Sem. VIII for lateral entry students.

Note: An equivalent certificate of CGPA to percentage of marks will be provided to student on candidate's demand after remitting prescribed fees by Shivaji University.

Awards of Grades for Re-Examination:

1. There will be Re-examination for all failure ESE theory/practical courses in a year after even semester immediately the result declaration of ESE and before the commencement of next academic year.
2. A student will apply for re-examination before the last date of such application and will appear for re-examination.
3. In such cases In Semester Examination performance of a student will not be wiped out.
4. The weightage similar to ESE will be given to re-examination.
5. A student who is eligible for re-examination but remains absent for re-examination will be given grade 'Absent'.
6. If the student fails in an odd semesters (1, 3, 5, 7) and/or even semesters (2, 4, 6, 8) in ESE of theory/practical credit course in an academic year shall be allowed to appear for re-examination.
7. There will be ESE examination of theory and practical courses of semester 1, 3, 5 and 7 at the end of odd semester, there will be ESE examination of theory and practical courses of semester 2, 4, 6 and 8 at the end of even semester and there will be re-examination for all ESE theory and practical courses from semester 1 to semester 8 after one month of declaration of result of even semester.

8. If the student fails to clear the ESE of theory/practical course even in re-examination conducted after even semesters (2, 4, 6, 8) in a year, he/she shall have to re-appear in subsequent concern odd semesters (3, 5, 7) or concern even semesters (4, 6, 8) ESE of theory/practical credit course examination in next academic year for the failed ESE of theory/practical credit course examination of concern odd semester or concern even semester that she/he has failed in previous academic year.

9. The candidate can apply for revaluation of photocopy of re-examination for ESE of theory/practical course conducted after even semesters (2, 4, 6, 8).

10. A student will be awarded a grade given in Table of **R. R. B. Tech. 9** depending upon the cumulative marks obtained by him/her in Re-examination.

Shivaji University, Kolhapur

T.Y.B.Tech. (NEP2.0 Pattern)

Question Paper Patten

Question Number	Chapter	Marks	Total Marks	Details
Q.No.01	01,02,03	05	15	Solve any 03 out of 04
Q. No. 02	04	05	15	Solve any 03 out of 04
Q. No. 03	05	05	15	Solve any 03 out of 04
Q. No. 04	06	05	15	Solve any 03 out of 04

1. Solve any Three (5*3)=15 Marks
a)
b)
c)
d)
2. Solve any Three (5*3)=15 Marks
a)
b)
c)
d)
3. Solve any Three (5*3)=15 Marks
a)
b)
c)
d)
4. Solve any Three (5*3)=15 Marks
a)
b)
c)
d)

Second Year Exit: Teaching Methodology, Assessment and Evaluation

1. As per R. R. B. Tech. 12.2 Rule: Award of Degree

If a student passes all the courses of first year, second year and earns the requisite number of credits, the student will become entitled to Undergraduate Diploma (Two years or four semesters) in the programme of his/her major subject. If he/she wants to exit, can exit the programme with UG Diploma certificate. However, for the award of two years UG Diploma Certificate in Major with 88 credits, an additional 8 credits from Exit Courses are required to earn.

2. Second Year Exit Course:

Methodology 1:

1. The students should complete two online certification courses (NPTEL) related to their programme, each of 3 credits. In addition to this, they will also need to complete 2 credits worth of two Virtual Lab work related to online certification courses. These additional 8 credits earn by students shall be based upon skill based vocational courses or internship/Apprenticeship.

2. The NPTEL courses are likely to be available online and can be completed at the student's own pace. The content will be specific to the student's field of study or programme. The skill based vocational courses shall be analogous to the Baskets/Areas provided by the concerned BoS.

3. The student must complete two virtual lab work that adds 2 credits to simulate practical or experimental learning experiences in a controlled virtual environment.

4. **Examination scheme:** The marks gained from the two NPTEL Courses (3 credits each) are converted to a total of 100 marks. The report for the two Virtual Lab work of 2 credits will be evaluated for 25 marks.

The report should include a detailed write-up and analysis of the virtual lab experiments conducted, encompassing the methodology, results, and conclusions.

5. There may be uncertainty in availability of the NPTEL courses offered by concerned BoS as there is continuous updatation of the NPTEL courses. The students can choose equivalent NPTEL course of the required duration with prior permission from the concerned institute. The concerned institute should communicate to Concerned BoS for their permission. For NPTEL course registration, the students are required to visit to website https://swayam.gov.in and create their account. Log in the account and join the required course and follow the instructions to compete the course. Similarly, for Virual Lab, the students are required to visit to website https://www.vlab.co.in and create their account. Log in the account and join the required lab and follow the instructions to compete the course (need to perform all listed experiments under that Lab). To fulfill the requirement of 06 credits, students can go for two courses each of 12 weeks.

Methodology 2:

3. The students should complete two online certification courses (NPTEL) related to their programme, each carrying 2 credits. In addition to this, they will also need to complete 4 credits worth of two physical internship/Apprenticeship (each of 40 hrs) work from relevant industry. These additional 8 credits earned by the students shall be based upon skill based vocational courses or internship/Apprenticeship.

4. The NPTEL courses are likely to be available online and can be completed at the student's own pace. The content will be specific to the student's field of study/programme. The skill-based vocational courses shall be analogous with the list provided by the concerned BoS.

5. The student should complete two physical internship/Apprenticeship (each of 40 hrs) work from relevant industrial practices that adds 4 credits to simulate practical or experimental learning experiences in a controlled virtual environment.

6. **Examination scheme:** The marks gained from the two NPTEL Courses (2 credits each) are converted to a total of 100 marks. The report for the performed two physical internship/Apprenticeship (each of 40 hrs) work from relevant industrial practices of 4 credits will be evaluated for 25 marks. The report should include a detailed write-up and analysis of two physical internship/Apprenticeship (each of 40 hrs) work along with certificate of internship/Apprenticeship from relevant industrial practices conducted, encompassing the methodology, results, and conclusions.

7. There may be uncertainty in availability of the NPTEL courses offered by concerned BoS as there is continuous updatation of the NPTEL courses. The students can choose equivalent NPTEL course of the required duration with prior permission from the concerned institute. The concerned institute should communicate to Concerned BoS for their permission. For NPTEL course registration, the students are required to visit to website https://swayam.gov.in and create their account. Log in the account and join the required course and follow the instructions to compete the course.

8. **Examination scheme:** The marks gained from the two NPTEL Courses (2 credits each) are converted to a total of 100 marks. The report for the performed two physical internship/Apprenticeship (each of 40 hrs) work from relevant industrial practices of 4 credits will be evaluated for 25 marks. The report should include a detailed write-up and analysis of two physical internship/Apprenticeship (each of 40 hrs) work along with certificate of internship/Apprenticeship from relevant industrial practices conducted, encompassing the methodology, results, and conclusions.

9. There may be uncertainty in availability of the NPTEL courses offered by concerned BoS as there is continuous updatation of the NPTEL courses. The students can choose equivalent NPTEL course of the required duration with prior permission from the concerned institute. The concerned institute should communicate to Concerned BoS for their permission. For NPTEL course registration, the students are required to visit to website https://swayam.gov.in and create their account. Log in the account and join the required course and follow the instructions to compete the course.

Guidelines for Open Elective Courses: Teaching Methodology, Assessment and Evaluation

Open Elective (OE) courses other than faculty of Science and Technology through Massive Open Online Courses (MOOCs) allowing students to engage with a broad spectrum of ideas and knowledge areas. The OE courses are likely to be available online and can be completed at the student's own pace within a set timeframe. For OE course, students are required to visit to the website https://swayam.gov.in for registration and create an account. Afterward, students should Login the account and join the course assigned by the course coordinator and follow the instructions to compete the course through self-learning mode. Additionally, the respective institution should download the relevant study materials to ensure students have access to them as needed. Minimum 25 students can register for one OE course in the concerned institute. There will be one course coordinator for one OE course. Students need to cover OE Courses of 08 credits. These 08 credits over semesters III to V. OE courses are chosen from faculty other than Faculty of Science and Technology. It is offered in Second and Third year as per Semester wise credit distribution table. Students need to take up the courses of 08 credits over semesters III to V.

1. **For Semester-III,** OE theory course of 3 credits consists of Mid Semester Examination (MSE) of 30 Marks, In Semester Evaluation/Continuous Assessment (ISE/CA) of 10 Marks and End Semester Examination (ESE) of 60 Marks.
2. **For Semester-III,** OE practical lab course of 1 credit consists of In Semester Evaluation/Continuous Assessment (ISE/CA) of 25 Marks

and End Semester Examination-Practical Oral Examination (ESE-POE) of 25 Marks. Course Coordinator assigned by Institute should complete the selected course practical through expert of that course. The lab exercises and demonstrations prepared by concern expert must be aligned with the specific OE course that the students have chosen.

3. **For Semester-IV,** OE theory course of 2 credits consists of Mid Semester Examination (MSE) of 30 Marks, In Semester Evaluation/Continuous Assessment (ISE/CA) of 10 Marks and End Semester Examination (ESE) of 60 Marks.
4. **For Semester-V,** OE theory course of 2 credits consists of Mid Semester Examination (MSE) of 30 Marks, In Semester Evaluation/Continuous Assessment (ISE/CA) of 10 Marks and End Semester Examination (ESE) of 60 Marks.
5. The Mid Semester Examination (MSE) of 30 Marks based on selected OE Course will be conducted by Concerned Departmental Course Coordinator. The course expert of concerned faculty should set question paper of MSE and evaluate the same.
6. Online submitted assignments by students using SWAYAM platform for concerned OE course will be used for In Semester Evaluation/Continuous Assessment (ISE/CA) of 10 Marks by Concerned Departmental Course Coordinator appointed for particular course by Principal of the Institute. Assignments may be of varied in nature for OE course.

7. The ESE of OE courses will be conducted by the University. The setting of question papers for both MSE and ESE, as well as the evaluation of the concerned OE course, should be carried out by the

course expert from the Board of Studies (BoS) of the respective faculty in accordance with the provisions under Panel of Paper Setters, Examiners, and Moderators – Clauses 41(f) and 48(3)(a).

8. MSE will be based on 50% syllabus from beginning (First 50% Weeks).
9. ESE paper setting weightage will be 25% on syllabus covered for MSE (First 50% Weeks) and 75% on remaining syllabus (Last 50% Weeks). The number of optional questions marks in a theory paper shall be 25 to 30 percent of the maximum marks.

Note: One OE course may be floated by the institute for 60 intake.

Open Electives Courses Offered to the students under Faculty of Science and Technology

In line with New Education Policy 2020

(Effective from Academic year 2025-26)

Open Electives

The students need to cover Open Elective Courses (OE) of 08 credits. These 08 credits over semesters III to V.

Semester wise credit distribution table for OE is given below

Sr. No.	Semester	Open Elective	Teaching scheme			Credits
			L	T	P	
01	III	OE-01	3	-	-	3
	III	OE-01 Lab	-	-	2	1
	IV	OE-02	2	-	-	2
02	V	OE-03	2	-	-	2
	Total		**7**	**-**	**2**	**8**

Semester wise baskets of OE from faculty other than Faculty of Science and Technology, Viz. Faculty of Commerce and Management, Faculty of Humanities and Faculty of Interdisciplinary Studies is given below

List of Open Elective Courses might be taken by students under Faculty of Science and Technology

Semester – III

Note: Choose any one course from the below basket of other than faculty in such way that the course with same name should not comes under or taught by major programme or the MDM.

Sr. No.	Name of the Course	Category	Duration (Weeks)	Credit Points	Institute Offering Course	Name of Professor/ Resource person	Link
01	Principles of Economics	Economics	12	03	IIT Madras	Prof. Sabuj Kumar Mandal	https://onlinecourses.nptel.ac.in/noc25_ec15/preview
02	German - I	Humanities and Social Science	12	03	IIT Madras	Prof. Milind Brahme	https://onlinecourses.nptel.ac.in/noc25_hs121/preview
03	Science, Technology and Society	Humanities and Social Science	12	03	IIT Guwahati	Prof. Sambit Mallick	https://onlinecourses.nptel.ac.in/noc25_hs189/preview
04	Environment and Development	Humanities and Social Science	12	03	IIT Guwahati	Prof. Ngamjahao Kipgen	https://onlinecourses.nptel.ac.in/noc25_hs195/preview
05	Logistics & Supply Chain Management	Humanities and Social Science	12	03	IIT Kharagpur	Prof. Vikas Thakur	https://onlinecourses.nptel.ac.in/noc25_hs205/preview
06	Introduction to Film Studies	Humanities and Social Sciences English studies	12	03	IIT Madras	Prof. Aysha Viswamohan	https://onlinecourses.nptel.ac.in/noc25_hs138/preview
07	Entrepreneurship	Management	12	03	IIT Madras	Prof. C Bhaktavatsala Rao	https://onlinecourses.nptel.ac.in/noc25_mg81/preview
08	Managerial Skills for Interpersonal Dynamics	Management	12	03	IIT Roorkee	Prof. Santosh Rangnekar	https://onlinecourses.nptel.ac.in/noc25_mg91/preview
09	Automation in Production Systems and Management	Management	12	03	IIT Kharagpur	Prof. Pradip Kumar Ray	https://onlinecourses.nptel.ac.in/noc25_mg135/preview
10	Numerical Methods for Engineers	Multidisciplinary	12	03	IIT Madras	Prof. Niket Kaisare	https://onlinecourses.nptel.ac.in/noc25_ge59/preview

Semester – IV

Note: Choose any one course from the below basket of other than faculty in such way that the course with same name should not comes under or taught by major programme or the MDM.

Sr. No.	Name of Course	Category	Duration (Weeks)	Credit Points	Institute Offering Course	Name of Professor/ Resource person	Link
01	Indian Business History	Humanities And Social Sciences	08	02	IIT Guwahati	Prof. Vipul Dutta	https://onlinecourses.nptel.ac.in/noc25_hs32/preview
02	Probability and Stochastic for Finance	Economic Sciences	08	02	IIT Kanpur	Prof. Joydeep Dutta	https://onlinecourses.nptel.ac.in/noc25_ma58/preview
03	Enhancing Soft Skills and Personality	Humanities and Social Sciences	08	02	IIT Kanpur	Prof. T. Ravichandran	https://onlinecourses.nptel.ac.in/noc25_hs87/preview
04	Mastering Speaking and Presentations: A case Based Approach	Humanities and Social Sciences	08	02	IIT Kharagpur	Prof. Seema Singh	https://onlinecourses.nptel.ac.in/noc25_hs96/preview
05	The Science of Happiness and Wellbeing	Humanities and Social Sciences	08	02	IIT Kharagpur	Prof. Priyadarshi Patnaik Prof. Manas K Mandal	https://onlinecourses.nptel.ac.in/noc25_hs103/preview
06	Philosophical Foundations Of Social Research	Humanities And Social Sciences	08	02	IIT Guwahati	Prof. Sambit Mallick	https://onlinecourses.nptel.ac.in/noc25_hs63/preview
07	Emotional Intelligence	Humanities and Social Science	08	02	IIT Kharagpur	Prof. Rabindra Kumar Pradhan	https://onlinecourses.nptel.ac.in/noc25_hs16/preview
08	Employment Communication: A Lab based course	Humanities and Social Science	08	02	IIT Kharagpur	Prof. Seema Singh	https://onlinecourses.nptel.ac.in/noc25_hs17/preview
09	Soft Skill Development	Humanities and Social Science	08	02	IIT Kharagpur	Prof. Priyadarshi Patnaik Prof. V. N. Giri Prof. D. Suar	https://onlinecourses.nptel.ac.in/noc25_hs72/preview
10	Social Behavior and the Brain: An Introduction to Social Neuroscience	Humanities and Social Science, Psychology, Neuroscience, Cognitive Science	08	02	IIT Kanpur	Prof. Ark Verma	https://onlinecourses.nptel.ac.in/noc25_hs101/preview
11	Economic Growth And Development	Humanities and Social Sciences	08	02	IIT Guwahati	Prof. Rajshree Bedamatta	https://onlinecourses.nptel.ac.in/noc25_hs11/preview

12	Effective Writing	Humanities and Social Sciences	08	02	IIT Roorkee	Prof. Binod Mishra	https://onlinecourses.nptel.ac.in/noc25_hs14/preview
13	Centre-State Relations in India	Law	08	02	IIT Kharagpur	Prof. Uday Shankar	https://onlinecourses.nptel.ac.in/noc25_lw04/preview
14	Foundation Course in Managerial Economics	Management	08	02	IIT Kharagpur	Prof. Barnali Nag	https://onlinecourses.nptel.ac.in/noc25_mg25/preview
15	International Marketing	Management	08	02	IIT Kharagpur	Prof. Biswarup Ghosh	https://onlinecourses.nptel.ac.in/noc25_mg32/preview
16	Introduction to System Dynamics Modeling	Management	08	02	IIT Bombay	Prof. Jayendran Venkateswaran	https://onlinecourses.nptel.ac.in/noc25_mg37/preview
17	Management of New Products and Services	Management	08	02	IIT Kharagpur	Prof. KBL Srivastava	https://onlinecourses.nptel.ac.in/noc25_mg44/preview
18	Business Forecasting	Management	08	02	IIT Bombay	Prof. Pankaj Dutta	https://onlinecourses.nptel.ac.in/noc25_mg66/preview
19	Yoga and Positive Psychology for Managing Career and Life	Management	08	02	IIT Bombay	Prof. Ashish Pandey	https://onlinecourses.nptel.ac.in/noc25_mg75/preview
20	Roadmap for patent creation	Multidisciplinary	08	02	IIT Kharagpur	Prof. Gouri Gargate	https://onlinecourses.nptel.ac.in/noc25_ge30/preview

Semester – V

Note: Choose any one course from the below basket of other than faculty in such way that the course with same name should not comes under or taught by major programme or the MDM.

Sr. No.	Name of Course	Category	Duration (Weeks)	Credit Points	Institute Offering Course	Name of Professor/ Resource person	Link
01	Enhancing Study Skills	Multidisciplinary	08	02	Indira Gandhi National Open University, New Delhi	Dr. P. Lakshmi; Dr. G. Mythili	https://onlinecourses.swayam2.ac.in/nou25_ge69/preview
02	Community Engagement and Social Responsibility	Multidisciplinary	10	02	Dayalbagh Educational Institute, Agra, Uttar Pradesh	Prof. Akshay Kumar Satsangi	https://onlinecourses.swayam2.ac.in/ugc25_ge10/preview
03	Economic Environment and Business Strategy	Economics	8	02	IIT Kanpur	Prof. Sukumar Vellakkal	https://onlinecourses.nptel.ac.in/noc25_ec16/preview
04	Corporate Social Responsibility	Management	8	02	IIT Kharagpur	Prof. Aradhna Malik	https://onlinecourses.nptel.ac.in/noc25_mg139/preview
05	Soft Skill Development	Humanities and Social Science	8	02	IIT Kharagpur	Prof. Priyadarshi Patnaik, Prof. V. N. Giri, Prof. D. Suar	https://onlinecourses.nptel.ac.in/noc25_hs142/preview
06	Developing Soft Skills and Personality	Humanities and Social Science	8	02	IIT Kanpur	Prof. T Ravichandran	https://onlinecourses.nptel.ac.in/noc25_hs174/preview
07	Introduction to Advanced Cognitive Processes	Humanities and Social Science	8	02	IIT Kanpur	Prof. Ark Verma	https://onlinecourses.nptel.ac.in/noc25_hs177/preview
08	Entrepreneurship and IP Strategy	Humanities and Social Science	8	02	IIT Kharagpur	Prof. Gouri Gargate	https://onlinecourses.nptel.ac.in/noc25_hs213/preview
09	Artificial Intelligence, Law and Justice	Law	8	02	NALSAR University of Law	Prof. Krishna Ravi Srinivas	https://onlinecourses.nptel.ac.in/noc25_lw12/preview
10	Innovation, Business Models and Entrepreneurship	Management	8	02	IIT Roorkee	Prof. Rajat Agrawal Prof. Vinay Sharma	https://onlinecourses.nptel.ac.in/noc25_mg95/preview
11	Organization Development and Change in 21st Century	Management	8	02	IIT Bombay	Prof. Ashish Pandey	https://onlinecourses.nptel.ac.in/noc25_mg103/preview

Guidelines for Multidisciplinary Minor (MDM) Programmes

As per the directives of the Government of Maharashtra, engineering colleges are encouraged to update their curricula in alignment with the guidelines of the National Education Policy (NEP) 2020. As part of this transformative initiative, the 'Minor Programme' has been introduced to promote multidisciplinary learning at the undergraduate level. These programmes are structured to provide students with interdisciplinary knowledge, enhancing their core academic disciplines and preparing them to meet the evolving demands of the global job market.

Minor programmes across various disciplines have been introduced to provide students with the opportunity to explore fields beyond their core B. Tech curriculum. These programmes enable students from specific branches to broaden their knowledge and skill sets. For example, a student pursuing Electrical Engineering can opt for a Minor in Computer Science and Engineering, thereby acquiring interdisciplinary expertise that enhances both academic depth and professional flexibility. However, students enrolled in the Computer Science and Engineering (CSE) programme are restricted from choosing MDM's in Artificial Intelligence and Data Science, CSE (Data Science), and CSE (Artificial Intelligence and Machine Learning) in order to prevent overlap between the core curriculum of CSE and the content of these minors, ensuring that students gain diverse and non-redundant knowledge through their minor specializations. **(Refer Table: MDM Courses)**

Common guidelines to students:

1. The Multidisciplinary Minor (MDM) must be compulsorily chosen from engineering discipline different from the student's Major engineering programme. Students should take MDM from the list of MDM Offered by Other Departments/Branches/ programmes only. Ex: A Student of Electrical Engineering should take MDM from other departments/branches/Programmes except MDM offered by Electrical Engineering Dept. **(Refer Table: MDM Courses)**
2. The entry point for any compulsory MDM programme is the 3rd semester. The required credits for MDM courses must be acquired from the 3rd semester of second year to the final year of UG Programme.
3. A student is required to continue with the selected Minor programme consistently throughout all six semesters.
4. No changes to the selected Minor programme will be permitted under any circumstances.
5. A student may choose only one Minor programme (track), from the list of MDM courses offered by the institute.
6. The allotment of the MDM course will be based on the marks obtained by the student in the first year for Sem-I and Sem-II combinely.
7. The compulsory MDM programme will admit a maximum of 75 students into its minor course, with selection strictly based on first-year academic merit. Preference order for allocating MDM minor will follow the hierarchy: Candidates with no backlogs first, then those with one backlog, followed by those with two backlogs, and so on.

8. All students must complete the Google form provided by the Institute, indicating their preferences to MDM programme within the specified deadline. Students should ensure that they enter their accurate first year marks in the form along with the attachment of marksheets of Sem-I and Sem-II to avoid any discrepancies.

(Refer Table: MDM Courses)

List of S. Y. B. Tech. and T.Y.B.Tech MDM Courses Offered by the Various Programmes under the Faculty of Science and Technology at Shivaji University, Kolhapur

Sr. No.	Name of the Programme (Major) Offering MDM	Name of the corresponding Minor Programme to be offered	Semester	Name of the MDM Course offered by the Major Programme	Teaching scheme			Credits
					L	T	P	
01	Mechanical Engineering	1. Computer Science and Engineering 2. Electronics and Computer Science 3. Computer Science and Engineering (AIML) 4. Civil Engineering 5. Electronics and Telecommunication Engineering 6. Computer Science and Engineering (Data Science) 7. Electrical Engineering 8. Artificial Intelligence & Data Science 9. Electrical and Computer Engineering	III	MDM 01: Thermodynamics	2	-	-	2
			IV	MDM 02: Theory of Machines	2	-	-	2
			V	MDM 03:Heat Power Engineering	3	-	2	4
			VI	MDM 04: Machine Design	2	-	-	2
02	Computer Science and Engineering	1. Mechanical Engineering 2. Civil Engineering 3. Electronics and Telecommunication Engineering 4. Electrical Engineering 5. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Data Structures using C	2	-	-	2
			IV	MDM 02: Object Oriented Programming	2	-	-	2
			V	MDM 03: Java Programming	3	-	2	4
			VI	MDM 04: Database Engineering	2	-	-	2

03	Electronics and Computer Science	1. Mechanical Engineering 2. Civil Engineering 3. Electrical Engineering 4. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Logic Design	2	-	-	2
			IV	MDM 02: Electronics Measurements	2	-	-	2
			V	MDM 3 : Microprocessor and Microcontroller	3	-	2	4
			VI	MDM 4 : Introduction to IOT	2	-	-	2
04	Computer Science and Engineering (AIML)	1. Mechanical Engineering 2. Civil Engineering 3. Electronics and Telecommunication Engineering 4. Electrical Engineering 5. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Object Oriented Programming	2	-	-	2
			IV	MDM 02: Introduction to AI	2	-	-	2
			V	MDM 03: Database Management	3	1	-	4
			VI	MDM 04: Internet of Things	2	-	-	2
05	Civil Engineering	1. Mechanical Engineering 2. Computer Science and Engineering 3. Electronics and Computer Science 4. Computer Science and Engineering (AIML) 5. Electronics and Telecommunication Engineering 6. Computer Science and Engineering (Data Science) 7. Electrical Engineering 8. Artificial Intelligence & Data Science 9. Electrical and Computer Engineering 10. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Building Construction	2	-	-	2
			IV	MDM 02: Waste Management	2	-	-	2
			V	MDM 3 : Infrastructure Engineering	3	-	2	4
			VI	MDM 4: Concrete Technology	2	-	-	2

06	Electronics and Telecommunication Engineering	1. Mechanical Engineering 2. Computer Science and Engineering 3. Computer Science and Engineering (AIML) 4. Civil Engineering 5. Computer Science and Engineering (Data Science) 6. Electrical Engineering 7. Artificial Intelligence & Data Science 8. Electrical and Computer Engineering 9. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Electronics System	2	-	-	2
			IV	MDM 02: Electronics Measurements	2	-	-	2
			V	MDM-3: Communication Engineering	3	-	2	4
			VI	MDM-4:Mobile Technology	2	-	-	2
07	Computer Science and Engineering (Data Science)	1. Mechanical Engineering 2. Civil Engineering 3. Electronics and Telecommunication Engineering 4. Electrical Engineering 5. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: C Programming	2	-	-	2
			IV	MDM 02: Python Programming	2	-	-	2
			V	MDM 03:Programming using Java	3	-	2	4
			VI	MDM 4:Database concepts and Design	2	-	-	2
08	Electrical Engineering	1. Mechanical Engineering 2. Computer Science and Engineering 3. Electronics and Computer Science 4. Computer Science and Engineering (AIML) 5. Civil Engineering 6. Electronics and Telecommunication Engineering 7. Computer Science and Engineering (Data Science) 8. Artificial Intelligence & Data Science 9. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Introduction to Electrical and Electronics Circuits	2	-	-	2
			IV	MDM 02: Electrical Power System	2	-	-	2
			V	MDM 03:Electrical Machines	3	-	2	4
			VI	MDM 04:Power Electronics and Embedded System	2	-	-	2

09	Artificial Intelligence & Data Science	10. Mechanical Engineering 11. Civil Engineering 12. Electronics and Telecommunication Engineering 13. Electrical Engineering 14. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Fundamentals of AI	2	-	-	2
			IV	MDM 02: Python for Data Science	2	-	-	2
			V	MDM 03: Machine Learning	3	-	2	4
			VI	MDM 04: Deep Learning	2	-	-	2
10	Electrical and Computer Engineering	1. Mechanical Engineering 2. Civil Engineering 3. Electronics and Telecommunication Engineering 4. Mechanical and Mechatronics Engineering (Additive Manufacturing)	III	MDM 01: Renewable Energy Sources	2	-	-	2
			IV	MDM 02: Python Programming	2	-	-	2
			V	MDM 03: Operating System	3	-	2	4
			VI	MDM 04: Electrical Design Estimation And Costing	2	-	-	2
11	Mechanical and Mechatronics Engineering (Additive Manufacturing)	1. Computer Science and Engineering 2. Electronics and Computer Science 3. Computer Science and Engineering (AIML) 4. Civil Engineering 5. Electronics and Telecommunication Engineering 6. Computer Science and Engineering (Data Science) 7. Electrical Engineering 8. Artificial Intelligence & Data Science 9. Electrical and Computer Engineering	III	MDM 01: Computer Aided Design (CAD)	2	-	-	2
			IV	MDM 02: Product Design & Development	2	-	-	2
			V	MDM 03: Fundamentals of Design for Product Manufacturing (FDPM)	3	-	2	4
			VI	MDM 04:Ergonomics & Human Factors	2	-	-	2

Third Year Exit: Teaching Methodology, Assessment and Evaluation

1. **As per R. R. B. Tech. 12.3 Rule: Award of Degree**

If a student passes all the courses of first year, second year and third year and earns the requisite number of credits, the student will become entitled to three years Bachelor's Degree in Vocational in the faculty of his/her major subject. If he/she wants to exit, can exit the programme with three years Bachelor's Degree in Vocational. However, for the award of three years Bachelor's Degree in Vocational in the faculty of his/her major subject with 132 credits, an additional 8 credits from Exit Courses are required to earn.

2. **Third Year Exit Course:**

Methodology 1:

1. The students should complete two online certification courses (NPTEL) related to their programme, each of 3 credits. In addition to this, they will also need to complete 2 credits worth of two Virtual Lab work related to online certification courses. These additional 8 credits earn by students shall be based upon skill based vocational courses or internship/Apprenticeship.
2. The NPTEL courses are likely to be available online and can be completed at the student's own pace. The content will be specific to the student's field of study or programme. The skill based vocational courses shall be analogous to the Baskets/Areas provided by the concerned BoS.
3. The student must complete two virtual lab work that adds 2 credits to simulate practical or experimental learning experiences in a controlled virtual environment.

4. **Examination scheme:** The marks gained from the two NPTEL Courses (3 credits each) are converted to a total of 100 marks. The report for the two Virtual Lab work of 2 credits will be evaluated for 25 marks. The report should include a detailed write-up and analysis of the virtual lab experiments conducted, encompassing the methodology, results, and conclusions.

5. There may be uncertainty in availability of the NPTEL courses offered by concerned BoS as there is continuous updatation of the NPTEL courses. The students can choose equivalent NPTEL course of the required duration with prior permission from the concerned institute. The concerned institute should communicate to Concerned BoS for their permission. For NPTEL course registration, the students are required to visit to website https://swayam.gov.in and create their account. Log in the account and join the required course and follow the instructions to compete the course. Similarly, for Virual Lab, the students are required to visit to website https://www.vlab.co.in and create their account. Log in the account and join the required lab and follow the instructions to compete the course (need to perform all listed experiments under that Lab). To fulfill the requirement of 06 credits, students can go for two courses each of 12 weeks.

Methodology 2:

1. The students should complete two online certification courses (NPTEL) related to their programme, each carrying 2 credits. In addition to this, they will also need to complete 4 credits worth of two physical internship/Apprenticeship (each of 40 hrs) work from relevant industry. These additional 8 credits earned by the students shall be based upon skill based vocational courses or internship/Apprenticeship.
2. The NPTEL courses are likely to be available online and can be completed at the student's own pace. The content will be specific to the student's field of study/programme. The skill-based vocational courses shall be analogous with the list provided by the concerned BoS.
3. The student should complete two physical internship/Apprenticeship (each of 40 hrs) work from relevant industrial practices that adds 4 credits to simulate practical or experimental learning experiences in a controlled virtual environment.
4. **Examination scheme:** The marks gained from the two NPTEL Courses (2 credits each) are converted to a total of 100 marks. The report for the performed two physical internship/Apprenticeship (each of 40 hrs) work from relevant industrial practices of 4 credits will be evaluated for 25 marks. The report should include a detailed write-up and analysis of two physical internship/Apprenticeship (each of 40 hrs) work along with certificate of internship/Apprenticeship from relevant industrial practices conducted, encompassing the methodology, results, and conclusions.
5. There may be uncertainty in availability of the NPTEL courses offered by

concerned BoS as there is continuous updatation of the NPTEL courses. The students can choose equivalent NPTEL course of the required duration with prior permission from the concerned institute. The concerned institute should communicate to Concerned BoS for their permission. For NPTEL course registration, the students are required to visit to website https://swayam.gov.in and create their account. Log in the account and join the required course and follow the instructions to compete the course.

Design Thinking Course: Teaching Methodology, Assessment, and Evaluation

- The Non Credit Course under Design Thinking Category is offered to the students in Fifth or Sixth Semester through Massive Open Online Courses (MOOCs), and students may select a course from the following list or relevant course available on the respective online platform at that time. The course should have duration of not less than 4 weeks and not more than 6 weeks with minimum of 20 lectures and maximum of 30 lectures.
- The course is learned in online mode and can be completed by the student at their own pace within the prescribed duration.
- For enrollment, students are required to visit the SWAYAM or Coursera platform, register, and create their individual accounts.
- After successful registration, students must log in to their accounts, enroll in the course, and follow all instructions provided to complete the course.
- A Departmental Course Coordinator shall be appointed for the respective course.
- Students must submit all weekly assignments available on the respective platform, or those assigned by the Course Coordinator with prior approval from the respective Course Coordinator for assessment and evaluation.
- The Institute shall issue a Course Completion Certificate to students only after fulfilment of the following requirement:

  - Successful Completion and submission of 100% of the weekly assignments.

- Students are expected to adhere to all course guidelines and complete the course within the stipulated timeframe specified on the respective platform or by the Course Coordinator.

Online Platform- Swayam

1] Course Title- Design Thinking

Instructor-
Dr. Rajeshwari Patil, Dr. Manisha Shukla, Dr. Deepali Raheja, Dr. Mansi Kapoor

Sri Balaji University Pune

Course Information

Welcome to the captivating world of Design Thinking! This online course is designed to introduce you to the essential principles and techniques of Design Thinking—a powerful approach to problem-solving and innovation that has gained widespread recognition across various sectors in today's contemporary era.

In this course, you will discover that Design Thinking is much more than mere thinking. It is a mindset—an innovative and human-centric approach to identifying problems, designing effective solutions, and delivering outcomes that address unmet human needs.

Are you ready to unlock your creative potential and become a visionary leader in the business world? Join us on an exhilarating journey as we dive deep into the transformative power of design thinking through our immersive MOOC course on "Design Thinking."

Prepare to embark on a dynamic adventure where you will explore cutting-edge methodologies, challenge conventional thinking, and develop the essential skills to drive innovation. By participating in this course, you will be equipped with actionable strategies to tackle complex problems, discover untapped opportunities, and create value in today's ever-evolving business landscape.

Get ready to unleash your imagination, collaborate with like-minded individuals, and revolutionize your approach to problem-solving. Enroll now and embrace the boundless possibilities that await you!

This course adopts the Learner-Centric Model approach developed by IIT Bombay while planning, designing, and conducting this MOOC.

Learning Objectives-

This course will help you gain a strong foundation in design thinking principles and equip you with the necessary skills to apply this methodology in your future endeavors. Also, this course will help you to develop a problem-solving mindset and the ability to approach challenges from a human-centered perspective.

Course outline-

Week 0: Welcome to the course
Week 1: Foundation of Design Thinking
Week 2: Empathy-Foundation and Tools of Empathy
Week 3: Define-Foundation and Tools
Week 4: Ideate-Foundation and Tools
Week 5: Prototype & Foundation and Tools
Week 6: Learn From Practitioner

Syllabus-

Week/ Module	Topics
Week 0	• Demo Video • Welcome to the course • Course Schedule ● Grading Policy ● Exam Details ● FAQ
Week 1	**Foundation of Design Thinking** • Introduction to Design Thinking • Significance of Design Thinking • Key Tenets of Design Thinking • Design Thinking Process- 4 Critical Questions • Design Thinking Process • Wicked Problems • How Design Thinking is Different from Traditional Thinking • The Knowledge Funnel • Cognitive Bias: What Design Thinkers Should Avoid •
Week 2	**Empathy-Foundation and Tools of Empathy** • Foundation of Empathy • Purpose of empathy • Observation as a tool of empathy • Methods of Observation • Empathetic Interview • Stakeholder maps • Jobs to be done • Empathy Maps
Week 3	**Define- Foundation and tools** • Rules of Defining • Importance of Defining • Customer Journey Map • Customer experience • Persona
Week 4	**Ideate-Foundation and Tools** • Introduction to Ideation • Double Diamond • Brainstorming • Rules for Brainstorming • Mind Mapping • Worst Possible Idea

Week 5	**Prototype -Foundation and Tools** • Concept of Prototyping • Paper prototype • Story Board prototype • Scenario prototype • Low fidelity and high fidelity Test Foundation and Tools • Introduction to Test
Week 6	**Learn from Practitioner** • Interview 1 Mr Rohit Dubepatil - Director ORAH Nutrichem.Pvt.Ltd • Interview 2 Dr Bala Ramadurai • Interview 3Mr Abhijeet Kumar- Founder StepBeta • Interview 4 Ms Savita Rajiv

Online Platform- Coursera

Course Title- Design Thinking and Innovation

Instructor:

B K Chakravarthy –
IIT Bombay

Syllabus-

Module 1-Innovation by Design:
Introducing the fundamental concepts of design thinking and the 7 Concerns for Innovation. This module will establish the foundation for understanding how design can solve complex problems by focusing on user needs and iterative innovation. Understand the principles of design thinking. Familiarize yourself with the 7 Concerns for Innovation. Recognize the importance of collaboration in the innovation process.

Module 2- The resolve to solve a problem:
Every design project is initiated by a _need', which becomes _The Cause' of the entire journey that follows. This need may be a commercial requirement, a social necessity or a specific niggling problem with an existing product. The recognition of such a need is a key trigger for the project and it can be identified by any of the stakeholders connected to the product – a product manufacturer or marketer, a user or a product designer.

Module 3- Understanding the problem space:
To study and understand an existing product or similar products in the market, it is critical that the environment in which the product is used, which designers like to call 'The Context' is understood comprehensively. This means that a designer must study the users and their perspectives on the product. Often, this involves several rounds of interaction and observation.

Module 4- Arriving at a Design insight:
At this stage, the designer analyses all the information gathered and methodically lists out their observations and perceptions of any notable issues in the use of the product. Such analysis results in the thorough, all-round 'Comprehension' of the product as it functions within the context of its use. The design insights thus arrived at give rise to creative ideas, and form the basis of the intervention that follows.

Module 5- Creating a product brief:
The Check' is an essential step in understanding what requirements the product should ultimately meet and what problems the design intervention should address. The check, which is often a document in the form of a product brief, is created from the design insights and must be approved by the client. The product brief is an important point of reference throughout the journey as concepts and prototypes are created and evaluated.

Module 6- Generating ideas and concepts:
At this stage called 'The Conception' , designer arrives at multiple ideas to come up with solutions for the problems listed using the product brief. At this crucial stage, ideas are proposed and grouped into clusters. This makes possible the consideration of multiple concepts. Finally, the team zeros in on one all-encompassing concept that best addresses all aspects of the product.

Module 7- Building Mockups and prototypes:
The final concept is further refined with reference to criteria like materials available or desirable, and the conditions in which the product is to be manufactured. At this penultimate stage, the designer creates several style options according to the user profile and selects one that best addresses all the aesthetic concerns. The chosen product design is showcased by 'Crafting' small-scale mock-up models, CAD models, or working prototypes. A final version of the product that meets all conditions in the product brief is then taken up for mass production.

Module 8- Delighting the user:

The last but critically important concern is 'The Connection' the new product makes with the user. This connection or the bond between the user and the product is formed only when the user is satisfied with the product‘s performance and begins to cherish it, which in turn creates an increasing demand for the product. In fact, it is the customer‘s satisfaction that makes a winning project and functions as the most important criterion for innovation.

SCHEME OF INSTRUCTION & SYLLABI

Programme Electrical Engineering

Scheme of Instructions: Third Year B.Tech.in Electrical Engineering

Semester–V

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/Wk	Course Credits	EXAM SCHEME			
									MSE	ISE/CA	ESE	TOTAL
1	PCC	EE0351	Electrical Power Transmission and Distribution	3	--	--	3	3	30	10	60	100
2	PCC	EE0352	Control Systems	3	--	--	3	3	30	10	60	100
3	PCC	EE0353	AC Machines	3	--	--	3	3	30	10	60	100
4	PEC	EE0354	PEC I	3	--	--	3	3	30	10	60	100
5	MDM	EE0355	Multi-disciplinary Minor–03	3	--	--	3	3	30	10	60	100
6	OE	EE0356	OpenElective-03	2	--	--	2	2	30	10	60	100
7	PCC	EE0357	Control System Lab	--	--	2	2	1	-	25	25	50
8	PCC	EE0358	AC Machines Lab.	--	--	2	2	1	-	25	25	50
9	PEC	EE0359	PEC I	--	--	2	2	1	-	25	--	25
10	MDM	EE03510	Multi-disciplinary Minor–03Lab	--	--	2	2	1	-	50	--	50
11	EL	EE03511	Minor Project 01	--	--	2	2	1	-	25	--	25
			Total	**17**	**--**	**10**	**27**	**22**	**180**	**210**	**410**	**800**

L-Lecture T-Tutorial P-Practical

MSE-Mid Semester Examination ISE/CA-In Semester Evaluation/Continuous Assessment ESE-End Semester Examination (For Laboratory End Semester performance)

Course Category	Basic Science Courses (BSC)	Engineering Science Courses(ESC)	Programme Core Course (PCC)	Programme Elective Course (PEC)	Open Elective other than Particular Programme (OE/MDM)	Vocational and Skill Enhancement Course(VSEC)	Humanities Social Science and Management(HSSM)	Experiential Learning (EL)	Co-curricular and Extracurricular Activities (CCA)
Last Sem. Cumulative Sum	**16**	**16**	**22**	**-**	**10**	**07**	**13**	**02**	**02**
Semester Credits	**-**	**-**	**11**	**04**	**06**	**-**	**-**	**01**	**-**
Cumulative Sum	**16**	**16**	**33**	**04**	**16**	**07**	**13**	**03**	**02**

PROGRESSIVE TOTAL CREDITS :88+22=110

SCHEME OF INSTRUCTION & SYLLABI

Programme Electrical Engineering

Scheme of Instructions: ThirdYearB.Tech.in Electrical Engineering

Semester–VI

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs/Wk	Course Credits	EXAMSCHEME			
									MSE	ISE/CA	ESE	TOTAL
1	PCC	EE0361	Power Electronics	3	--	--	3	3	30	10	60	100
2	PCC	EE0362	Advanced Control System	3	1	--	4	4	30	10	60	100
3	PCC	EE0363	Power System analysis	3	--	--	3	3	30	10	60	100
4	PEC	EE0364	PEC-II	3	--	--	3	3	30	10	60	100
5	PEC	EE0365	PEC III	3	--	--	3	3	30	10	60	100
6	MDM	EE0366	Multi-disciplinary Minor–04	2	--	--	2	2	30	10	60	100
7	PCC	EE0367	Power Electronics Lab.	--	--	2	2	1	-	50	25	75
8	PCC	EE0368	Advanced Control System Lab.	--	--	2	2	1	-	50	25	75
9	EL	EE0369	Minor Project -02	--	--	4	4	2	-	50	--	50
			Total	**17**	**1**	**8**	**26**	**22**	**180**	**210**	**410**	**800**

L-Lecture T-Tutorial P-Practical

MSE-Mid Semester Examination ISE/CA-In Semester Evaluation/Continuous Assessment ESE-End Semester Examination (For Laboratory End Semester performance)

Course Category	Basic Science Courses (BSC)	Engineering Science Courses (ESC)	Programme Core Course (PCC)	Programme Elective Course(PEC)	Open Elective other than particular Programme (OE/MDM)	Vocational and Skill Enhancement Course(VSEC)	Humanities Social Science and Management(HSSM)	Experiential Learning (EL)	Co-curricular And Extracurricular Activities (CCA)
Last Sem. Cumulative Sum	**16**	**16**	**33**	**04**	**16**	**07**	**13**	**03**	**02**
Semester Credits	**-**	**-**	**12**	**06**	**02**	**--**	**-**	**02**	**-**
Cumulative Sum	**16**	**16**	**45**	**10**	**18**	**07**	**13**	**05**	**02**

PROGRESSIVE TOTAL CREDITS :110+22=132

Exit option: Award of B. Vocational in Major with 132 credits and an additional 8 credits from following Exit Courses				
Sr. No	**Course Code**	**Course Title**	**Mode**	**Credits**
1		Transformer Installation process	Online/offline certification Course	8
OR				
2		Industrial Installation Maintenance		8

SHIVAJI UNIVERSITY, KOLHAPUR				
Third Year(Sem.–V) B. Tech. Electrical Engineering				
PCC EE0351 Electrical Power Transmission and Distribution				
Teaching Scheme			**Examination Scheme**	
Lectures	**3 Hrs/Week**		**MSE**	30 Marks
Practical/Tutorials	**00Hr/Week**		**ISE/CA**	10 Marks
Total Credits	**03**		**ESE**	60 Marks
			Duration of ESE	02 Hrs. 30 Min.

Course Objectives: The objective of the course is to

1. To understand the structure and operation of electric power supply systems, including AC transmission, transmission voltage selection, and requirements of a satisfactory electric supply.

2. To study the mechanical design aspects of overhead transmission lines, including conductors, line supports, insulators, corona effects, and sag calculations.

3. To analyze the electrical parameters of transmission lines such as resistance, inductance, capacitance, skin effect, and evaluate the performance of short, medium, and long transmission lines.

Course Outcomes(CO):After end of the successful completion them course,thestudent will be able to

CO1	Analyze the need for high transmission voltages by comparing a.c. and d.c. transmission, considering economic and performance requirements of a satisfactory electric supply.
CO2	Describe the mechanical components of overhead transmission lines and evaluate insulator performance, corona effects, and sag to ensure safe, reliable, and efficient overhead line design.
CO3	Determine transmission line electrical parameters such as resistance, inductance, and capacitance using concepts of skin effect, flux linkages, and GMD for single-phase and three-phase overhead lines.
CO4	Analyze the performance of short, medium, and long transmission lines by calculating voltage regulation, efficiency, and generalized circuit constants under various loading and power factor conditions.
CO5	Explain the structure and classification of distribution systems and analyze the design considerations and performance of AC distribution networks under balanced and unbalanced load conditions.
CO6	Identify and explain different types of substations, their equipment, bus-bar arrangements, and key diagrams to understand power transformation, switching, protection, and distribution functions.

Unit No.	Course Contents	CO	Hours
Unit1	**Electric Supply System** Typical a.c. Power Supply Scheme, Comparison of D.C. and A.C. Transmission, Advantages of high transmission voltage, Elements of a Transmission Line, Economic Choice of Transmission Voltage, Requirements of Satisfactory Electric Supply	**CO1**	**07**
Unit2	**Mechanical Design of Overhead Lines** Main components of overhead lines, conductor materials, Line supports. Insulators, types of insulators, potential distribution over suspension insulator string, string efficiency, methods of improving string efficiency, corona, factors affecting corona, advantages and disadvantages of corona, methods of reducing corona effect , sag in overhead lines	**CO2**	**07**

Unit3	**Electrical Design of Overhead Lines** Constants of a transmission lines, Resistance of a transmission line, Skin effect, Flux linkages, inductance of a single phase two wire line, inductance of a 3- phase overhead line, Concept of self GMD and mutual GMD, inductance formulae in terms of GMD, Electric Potential, Capacitance of a single phase two wire line, capacitance of a 3- phase overhead line,	**CO3**	**07**
Unit4	**Performance of Transmission Lines** Classification of overhead transmission line, important terms, performance of single phase short transmission lines, three phase short transmission lines, effect of load p.f. on regulation and efficiency, medium transmission lines, end condenser method, Nominal T-method, Nominal –π method, Long transmission lines, analysis using rigorous method, Generalized circuit constants of a transmission lines, determination of generalized constants for transmission lines	**CO4**	**07**
Unit5	**Distribution Systems** Distribution systems, classification of distribution systems, AC distribution systems, overhead versus underground system, connection schemes of distribution system, requirement of a distribution system, design consideration in distribution system, three phase unbalanced loads, four wire star connected unbalanced load.	**CO5**	**07**
Unit6	**Substation** Classification of substations, Comparison between Outdoor and indoor Sub-Stations. Transformer substations, Pole-Mounted Sub-Station , Underground Sub-Station, Symbols for Equipment in Sub-Stations, Equipment in a Transformer Sub-Station, Bus-Bar Arrangements in Sub-Stations, Terminal and Through Sub-Stations, Key Diagram of 66/11 kV Sub-Station, Key Diagram of 11kV/400 V Indoor Sub-Station	**CO6**	**07**

Text Books

1	Electric Power Transmission and Distribution S. Sivanagaraju& S. Satyanarayana — Pearson Education
2	Transmission and Distribution Electrical Engineering Colin Bayliss& Brian Hardy — Elsevier
3	Electric Power Distribution Engineering (4th Edition) TuranGönen, Chee-Wooi Ten & Ali Mehrizi-Sani — CRC Press
4	Transmission and Distribution of Power K. R. Siddhapura& D. B. Raval — Vikas Publishing

Reference Books

1.	Electric Power Distribution Equipment and Systems Thomas Allen Short — CRC Press
2.	Springer Handbook of Power Systems Edited by Konstantin O. Papailiou — Springer
3.	CIGRÉ Substations Handbook Edited by Terry Krieg & John Finn — Springer CIGRÉ Green Books

SHIVAJI UNIVERSITY, KOLHAPUR				
Third Year (Sem. V)B. Tech. Electrical Engineering				
PCC EE0352 Control Systems				
Teaching Scheme			**Examination Scheme**	
Lectures	03Hrs /week		**MSE**	30 Marks
Practical/Tutorials	00Hrs /week		**ISE/CA**	10 Marks
Total Credits	03		**ESE**	60 Marks
			Duration of ESE	02 Hours 30 Minutes

Prerequisite: Basic knowledge of mathematics and fundamental electrical and electronic engineering concepts is required for studying Control Systems.

Course Objectives:

To understand the basic principles and components of control systems including open-loop and closed-loop systems.

To analyze the performance and stability of control systems using time-domain and frequency-domain methods.

To design and evaluate controllers for improving the performance of engineering control systems.

Course Outcomes(CO): The student will be able to

CO1	Determine the transfer function using block diagram reduction and signal flow graph.
CO2	Analyze the mathematical model of electrical and mechanical systems.
CO3	Compute the transient and steady state response parameters of systems.
CO4	Analyze the stability of system in time & frequency domain.
CO5	Analyze the control system using state space representation.
CO6	Implement controllers for simple control systems.

Unit No.	Course Contents	CO	Hours
Unit1	**Introduction to Control System and Mathematical Modelling** Introduction, types of systems, feedback control system, Mathematical modelling of electrical, mechanical systems, force voltage and force current analogy, Determination of the transfer function using block diagram reduction and signal flow graph, components of control systems and its transfer function, pole zero concept.	**CO1**	**08**
Unit2	**Time Domain Analysis and Stability** Time response of first order systems, second order systems, analysis of steady state error, static error constants and type of system, time response specifications, concept of stability, Routh-Hurwitz criteria for stability.	**CO2**	**07**
Unit3	**PID Controller** Introduction to P, PI, PID controller, Ziegler and Nicholas rules for controller tunning, PID controller applications: Temperature control system, motion control system, level control system	**CO3**	**06**

Unit4	**Root Locus Technique** Definition of root locus, rules for plotting root loci, root contour, stability analysis using root locus, effect of addition of pole and zero on root locus.	**CO4**	**07**
Unit5	**Frequency Response Analysis of Control system** Introduction to frequency response, frequency domain performance specifications, stability analysis of system using bode plots, polar plot, Nyquist plot, co-relation between time domain and frequency domain.	**CO5**	**07**
Unit6	**State Space Representation** Introduction to State space, phase variable form, canonical form, conversion of transfer function to state space and vice versa, state transition matrix and its significance, Eigen values, Eigen vectors, solution of state equations, controllability and observability.	**CO6**	**07**

Text Books

Sr. No	Title	Author	Publisher	Edition
1	Control System Engineering	Norman Nise	Wiley Publication	Seventh
2	Control System Engineering	I.J. Nagrath M. Gopal	New Age International Publication	Fifth
3	Modern Control Engineering	Ogata	Prentice Hall	Fifth
4	Feedback Control Systems	U. A. Bakshi& S. C. Goyal	Technical Publications	Second

Reference Books

Sr. No	Title	Author	Edition
1.	Automatic Control System	Kuo &Golnaraghi	Ninth
2.	Control Systems: Theory and Applications	Smarajit Ghosh	Second
3.	Control Systems	N. C. Jagan	Third
4.	Feedback Control Systems	C.L. Phillips, R.D. Harbor	Fifth

Mapping of COs and POs

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	-	-	3	-	1	-	2	1	1	-
CO2	3	2	-	-	3	-	1	-	2	1	1	-
CO3	2	2	-	-	3	-	1	-	2	1	1	-
CO4	2	2	-	-	3	-	1	-	2	1	1	-
CO5	3	2	-	-	3	-	1	-	2	1	1	-
CO6	3	2	-	-	3	-	1	-	2	1	1	-

1: Slight (Low) 2: Moderate (Medium 3: Substantial (High)

Shivaji University, Kolhapur

Third Year (Sem.V) B. Tech. Electrical Engineering

PCC EE0353 AC Machines

Teaching Scheme		**Examination Scheme**	
Lectures	**03 Hrs/week**	**MSE**	**30 Marks**
Tutorials	**-**	**ISE/CA**	**10 Marks**
Total Credits	**2**	**ESE**	**60 Marks**
		Total =100 Marks	
		Duration of ESE 02 Hrs 30 Min	

Prerequisite: Basic Electrical Engineering, Engineering Mathematics and Engineering Physics.

Course Objectives:

The objectives of the course is:

1) Describe behavior of three phase and single-phase induction motor.
2) Interpreter various characteristics of 3 phase induction motor.
3) Identify various industrial applications for single phase and three phase induction motor.
4) Evaluate winding parameters of Synchronous Generator.
5) Analyses performance characteristics and testing of synchronous machine.

Course Outcomes:

At the end of successful completion of the course, the student will be:

CO1 Acquire the knowledge of working, constructional details of Single induction motor.

CO2 Understand the working principle of Three phase induction motor.

CO3 Understand working principle of Synchronous generator.

CO4 Understand the parameter of performance and testing of Synchronous generator.

CO5 Understand the Synchronous Motor.

Unit No.	**Content**	**CO**	**Hours**
Unit 1	**Three phase induction motor** Construction, types production rotating field and rotating field working principle for slipper equivalent circuit starter deep bar and double kg induction motor effect of harmonics on motor speed control methods.	**CO1**	**7**
Unit 2	**Application and testing of three phase induction motor** Industrial applications induction Chandra no load blocked prototype circle diagram.	**CO2**	**7**

Unit 3	**Single phase induction motor** Double revolving filled theory starting and running performance of single-phase induction motor equivalent circuit of single-phase induction motor type of single-phase motor principle and operation start and capacitor start and run in Russian motors shaded pole industrial motor fractional horsepower motors.	**CO3**	**7**
Unit 4	**Synchronous generator** Construction, types, applications, working principle, equation of induced emf, Pitch factor and distribution factor, MMF of distributed winding, torque equation, efficiency, armature reaction and its compensation effect of changing excitation defect of change in torque and speed, Hunting of synchronous machine and its prevention.	**CO4**	**7**
Unit 5	**Performance and testing of synchronous generator** Determination of voltage regulation by synchronous induction impedance method, MMS method, ZPF method, synchronization: importance and method parallel operation, load sharing between parallel connecting synchronous generator.	**CO5**	**7**
Unit 6	**Synchronous motor** Methods of starting of synchronous motors, different torque in synchronous motor, stability, synchronous condenser, synchronous phase modifier, V curve and inverted V curve of synchronous motors.	**CO6**	**7**

Reference Books:

1. B L Theraja and A K Theraja, Electrical Technology, S Chand Publication.
2. P S Bimbhra Electrical Machinery, Khanna publishers.
3. Charles I Hubert, Electric Machines: Theory, Operating Applications and Controls, Pearson Publication.

Text Books:

1. AshfaqHussain, Electrical Machines, DhanpatRai and Co.
2. V K Mehta, Principle of Electric Machines, S Chand publications.
3. D P Kothari, J Nagrath, Electric Machines, Tata Mc-Graw Hills Education.

Useful Link/NPTEL Course:	
1	**Electrical Machines II**
	By Prof. Suman Malati
	Electrical Machines II
	By Prof. G.Sridhara Rao, Prof. P. Sasidhara Rao

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	**3**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**
CO2	**3**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**
CO3	**3**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**
CO4	**3**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**
CO5	**3**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**
CO6	**3**	**2**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**-**	**-**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur				
Third Year(Sem.–V) B. Tech. Electrical Engineering				
PEC EE0354 Digital Protection				
Teaching Scheme			**Examination Scheme**	
Lectures	**3 Hrs/Week**		**MSE**	30 Marks
Practical/Tutorials	**00 Hr/Week**		**ISE/CA**	10 Marks
Total Credits	**3**		**ESE**	60 Marks
			Duration of ESE	02 Hrs 30 Min

Prerequisite- Electrical Machines, Basic Electronics / Analog Electronics, Measurements and Instrumentation

Course Outcomes (CO): After the successful completion of this course the student will be able to

CO1	Understand the fundamentals of power system protection, including the need, components, zones of protection, and basic relay characteristics.
CO2	Explain the working principles and applications of conventional (electromagnetic) and static relays used in power system protection.
CO3	Analyze the concepts and operation of digital and numerical relays, including signal processing, sampling, and microprocessor-based protection systems.
CO4	Apply protection techniques for transmission lines and power system equipment, and understand modern protection methods including circuit breakers, SCADA, and smart grid protection.

Unit No.	Course Contents	CO	Hours
Unit1	**Fundamentals of Power System Protection** Need and importance of protection ,Components of protection system , Zones of protection , Primary and backup protection , Relay terminology: sensitivity, selectivity, reliability, speed , Classification of relays	**CO1**	**06**
Unit2	**Conventional & Static Relays** Electromagnetic relays: attraction & induction type, Induction disc relay working, Static relays: advantages and limitations, Comparator techniques: Amplitude comparator, Phase comparator	**CO2**	**08**
Unit3	**Digital & Numerical Relays** Introduction to digital protection, Block diagram of digital relay, Sampling theorem, Signal conditioning & filtering, A/D conversion, Microprocessor-based relays, Numerical relays and comparison with static relays	**CO3**	**06**
Unit4	**Protection of Transmission Lines** Overcurrent protection, Directional relays, Distance protection: Impedance relay, Reactance relay , Mho relay , Carrier current protection	**CO4**	**06**
Unit5	**Protection of Power System Equipment** Transformer protection: Differential protection , Buchholz relay, Generator protection, Motor protection, Busbar protection	**CO4**	**08**
Unit6	**Circuit Breakers & Modern Protection** Arc formation and extinction, Types of circuit breakers: Oil, Air blast, SF_6, Vacuum, Comparison of CBs, Introduction to: SCADA-based protection, Adaptive protection, Smart grid protection concepts	**CO4**	**08**

Text Books

1	Power System Protection and Switchgear by Badri Ram, D. N. Vishwakarma, Publisher: McGraw Hill
2	Switchgear Protection and Power Systems by Sunil S. Rao Publisher: Khanna Publishers

3	Fundamentals of Power System Protection by S. R. Bhide
4	Power System Protection and Switchgear: Principles and Applications by Chirag Gupta et al.
Reference Books	
1.	Digital Protection for Power Systems by Allan T. Johns, Salman K. Salman
2.	Practical Power System Protection by Hewitson, Brown, Balakrishnan
3.	Electrical Power System Protection by C. Christopoulos, A. Wright
4.	Power System Protection: Fundamentals and Applications by John Ciufo, Aaron Cooperberg

Shivaji University, Kolhapur				
Third Year(Sem.–V)B. Tech. Electrical Engineering				
MDM EE0355 Electrical Machines				
Teaching Scheme			**Examination Scheme**	
Lectures	**3 Hrs/Week**		**MSE**	30 Marks
Tutorials	**00 Hr/Week**		**ISE/CA**	10 Marks
Total Credits	**3**		**ESE**	60 Marks
			Duration of ESE	02 Hrs 30 Min

Course Objectives: The objective of the course is to

1. To understand the construction, principle of operation, and performance characteristics of DC, induction, and synchronous machines.
2. To analyze torque, speed control, efficiency, and losses in three-phase and single-phase induction motors using analytical and numerical methods.
3. To develop knowledge of testing, modeling, and performance evaluation of alternators and synchronous motors under different operating conditions.

Course Outcomes(CO):

CO s	At the end of the successful completion of the course ,the student will be able to	Blooms Taxonomy
CO1	Analyze the construction, torque-slip characteristics, starting methods and speed control techniques of 3-phase induction motors.	Analyze
CO2	Evaluate the performance of 3-phase induction motors using efficiency analysis, equivalent circuit modeling, and special operating characteristics.	Evaluate
CO3	Distinguish between different types of single-phase induction motors based on their construction, working principles, and torque-slip characteristics	Distinguish
CO4	Analyze the performance characteristics of synchronous motors using torque equations, V-curves, and power factor control under leading and lagging conditions and systems.	Analyze
CO5	Describe the constructional features, types of rotors, armature windings, and derive the EMF equation of alternators considering pitch and distribution factors.	Describe
CO6	Analyze the operation of PMSM using vector control and field-oriented control (FOC), and evaluate solar-pumped motor systems with MPPT for variable-speed applications.	Analyze

Unit No.	**Course Contents**	**Hours**
Unit1	**Introduction of 3 Phase Induction Motor** Construction & Basics: Construction & types of 3-phase Induction motors, Rotor quantities (EMF, current, frequency, p.f). Torque Analysis: Torque equation, starting torque, and Running torque [Numerical]. Characteristics: Factors affecting torque, Condition for maximum torque, Torque-slip characteristics. Starters: Need for starters, Types: DOL, Autotransformer, Star-Delta, Rotor resistance starter. Control & Application: Speed control methods (Stator voltage, Stator Frequency, Rotor resistance), Applications of 3-phase Induction motors.	**07**
Unit 2	**Performance and Characteristics of 3 Induction Motor** Efficiency: Losses, efficiency calculation, and the power flow diagram. Modeling & Testing: Equivalent circuit, Phasor diagram, No-load & Blocked rotor tests. Analysis: Special Concepts: Induction Generator, Double cage motors, Cogging & Crawling.	**07**
Unit3	**Single Phase Induction Motors** Theory: Double field revolving theory. Types & Construction: Working of Split phase, Capacitor start/run, Shaded pole, Series motor, Universal motor. Characteristics: Torque-slip characteristics for all the above motors.	**07**

Unit4	**Synchronous Motors**	**07**
	Construction & Operation: Construction of synchronous motors, types (cylindrical rotor, salient pole), principle of operation, synchronous speed, and pull-outtorque. Characteristics: Torque equation, V-curves, power factor control (leading/lagging), hunting and damping. Starting & Control: Need for synchronous starters (pontoon, damper windings), methods of starting (auxiliary motor, star-delta), speed control, applications in power factor correction and constant speed drives.	
Unit5	**Alternators**	**07**
	Construction & EMF: Construction (cylindrical/salient pole rotors), types of windings, EMF equation, distribution and pitch factors [Numerical]. Performance: Equivalent circuit, voltage regulation (EMF, MMF, ZPF methods), losses, efficiency, and OCC/SCC tests. Operation & Control: Synchronization (dark lamp, synchroscope), parallel operation, load sharing, governors and exciters, applications in power generation.	
Unit6	**Advanced and Special Machines**	**07**
	SRM & BLDC: Switched reluctance motor (construction, torque production, control strategies), BLDC motor (trapezoidal/sinusoidal back-EMF, sensor less control, PWM). PMSM & Solar Pumped: PMSM (vector control, FOC), solar pumped motor systems (BLDC/PMDC with MPPT, system components, efficiency, variable speed pumping). Characteristics & Applications: Torque-speed curves, comparisons, applications in EVs, renewable, and industrial drives.	

Reference

Text Books

1	Electrical Machines, S. K. Bhattacharya, Tata Mc-Graw-Hill publication
2	Electrical Machines, I. J. Nagrath, D. P. Kothari, Tata Mc-Graw-Hill publication IV edition
3	V. K. Mehta "Principles of Electrical Machines". S. Chand Publishers, New Delhi
4	B. L. Theraja "A textbook of Electrical Technology" Volume II S. Chand Publishers, New Delhi

Reference Books

1.	Electrical Machinery by P. S. Bimhra : coverage of induction motors (Units 1-2), synchronous motors (Unit 4), alternators (Unit 5)
2.	Electric Machines by D.P. Kothari & I.J. Nagrath: coverage of induction motors (Units 1-2), synchronous motors (Unit 4), alternators (Unit 5)
3.	Special Electrical Machines by K.V. Bhadra, S. Gopalakrishnan, P.K. Pillai: coverage of Advanced and Special Machines (Unit 6),
4.	Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab -'Signals & system' -IInd Edition - Pearson Education.
5.	Electrical Machines, AshfaqHussain, DhanpatRai& Sons: : coverage of induction motors (Units 1-2), synchronous motors (Unit 4), alternators (Unit 5)

Shivaji University, Kolhapur

TY.B. Tech. Electrical Engineering

Open Elective-03- EE0356 Renewable Energy System

Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs./week		MSE	30 Marks
Tutorials	00 Hrs/week		ISE/CA	10 Marks
Practical	--		ESE	60 Marks
Total Credits	02		Duration of ESE	02Hrs,30Min

Prerequisite: Power Systems I

Course Objectives:

To understand the basic principles and significance of renewable energy sources.

To study various renewable energy technologies such as solar, wind, and biomass.

To analyze the design and performance of renewable energy systems.

To develop skills for the effective implementation and management of renewable energy systems.

Course Outcomes(CO):

At the end of successful completion of the course, the student will be:

CO1	Describe the environmental aspects of renewable energy resources.
CO2	Explain the operation of various renewable energy systems.
CO3	Design solar PV systems.
CO4	Assess Environmental and Economic Impacts
CO5	Explain different emerging energy conversion technologies and storage.
CO6	Understand Grid Integration and Policies

Unit No.	Course Contents	CO	Hours
Unit 1	Solar thermal systems Introduction,Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data (Numerical Problems)–Pyranometer and Pyrheliometer -Solar Thermal Collectors –General description and characteristics –Flat plate collectors – Heat transfer processes –Solar concentrators(Parabolic trough, Parabolic dish, Central Tower Collector)	**CO1**	**6**
Unit 2	Solar electric systems Introduction- Solar Photovoltaic –Solar Cell fundamentals, characteristics Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems – stand-alone and grid connected-Design steps for a Stand-Alone system; Applications –Street lighting, Domestic lighting and Solar Water pumping systems., classification, construction of Module, Panel and Array-Effect of shadowing-	**CO2**	**6**

Unit 3	Wind Energy Introduction–Wind Turbine Types (HAWT and VAWT) and their construction- Wind power curve-Betz's Law-Power from a wind turbine (Numerical Problems)-Wind energy conversion system (WECS) – Fixed–speed drive scheme- Variable speed drive scheme. - Effect of wind speed and grid condition(system integration). Small hydro power: Classification as micro, mini and small hydro projects - Basic concepts and types of turbines - Classification, Characteristics and Selection.	**CO3**	**6**
Unit 4	Energy from ocean Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Advantages and Limitations of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation –Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.	**CO3**	**6**
Unit 5	Biomass energy Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, factors affecting biogas generation, types of biogas plants –KVIC and Janata model	**CO4**	**6**
Unit 6	Energy storage Necessity Of Energy Storage-Pumped Storage-Compressed air storage-Flywheel Storage-Batteries storage-Hydrogen storage	**CO4**	**7**

References:

Text Books

1	Thomas E. Kissell, David M. Buchla, Thomas L. Floyd, Renewable energy systems,Pearson 2017
2	Khan B. H., Non-Conventional Energy Resources, Tata McGraw Hill, 2009.
3	D. P. Kothari, K. C. Singal, RakeshRanjan, Renewable Energy Sources and Emerging Technologies, Prentice Hall of India, New Delhi, 2009

Reference Books

1	A.A.M. Saigh (Ed): Solar Energy Engineering, Academic Press, 1977
2	Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental impact, Prentice Hall of India, 2001.
3	Boyle G. (ed.), Renewable Energy -Power for Sustainable Future, Oxford University Press, 1996
4	Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011
5	F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
6	G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002

General Instructions: 1. Minimum number of assignments should be 6 covering all topics.

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	**3**	**3**	**–**	**–**	**–**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**3**	**3**	**–**	**–**	**–**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO3	**3**	**3**	**–**	**–**	**–**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**3**	**–**	**–**	**–**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO5	**2**	**2**	**–**	**–**	**–**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO6	**2**	**2**	**–**	**–**	**–**	**–**	**-**	**-**	**–**	**–**	**-**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SHIVAJI UNIVERSITY, KOLHAPUR				
Third Year (Sem.V) B. Tech. Electrical Engineering				
PCC EE0357 Control System Lab				
Teaching Scheme			**Examination Scheme**	
Lectures	--Hrs /week		**MSE**	--
Practical	02Hrs /week		**ISE/CA**	25 Marks
Total Credits	01		**ESE**	25 Marks

Prerequisite: Basic knowledge of mathematics and fundamental electrical and electronic engineering concepts is required for studying Control Systems.

Course Objectives:

To understand the practical behavior of control systems using electrical and simulation-based experiments.

To analyze system performance using time response, frequency response, and stability analysis techniques.

To develop skills in modeling and simulation of control systems using modern software tools like MATLAB/Simulink.

To design and implement controllers such as PID controllers for improving system performance.

Course Outcomes(CO):At the end of successful completion of the course, the student will be

CO1	Understand the practical behavior of control systems and analyze time response characteristics of first and second order systems.
CO2	Determine stability and performance of control systems using frequency response methods.
CO3	Design and implement controllers such as PID controllers to improve system performance.
CO4	Model and simulate control systems using modern software tools such as MATLAB/Simulink.

Unit No.	Course Contents	CO	Hours
1	Introduction to MATLAB environment and basic control system commands.	**CO4**	**02**
2	To study time response of first order system using MATLAB.	**CO1**	**02**
3	To study time response of second order system and determine parameters such as rise time, peak time, settling time, and maximum overshoot using MATLAB.	**CO1**	**02**
4	To obtain step response and impulse response of a given transfer function using MATLAB.	**CO1**	**02**
5	To perform Block Diagram Reduction Technique and obtain overall transfer function using MATLAB.	**CO1**	**02**
6	To determine stability of a control system using Routh–Hurwitz criterion.	**CO2**	**02**
7	To obtain Root Locus of a control system using MATLAB.	**CO2**	**02**
8	To obtain Bode plot and determine gain margin and phase margin using MATLAB.	**CO2**	**02**
9	To obtain Nyquist plot of a control system and analyze stability.	**CO2**	**02**
10	To study the effect of PID Controller on system response using MATLAB/Simulink.	**CO3**	**02**
11	To write a MATLAB program to determine controllability of a given system using state-space representation.	**CO4**	**02**

12	To write a MATLAB program to determine observability of a given system using state-space representation.	**CO4**	**02**

Text Books

Sr. No	Title	Author	Publisher	Edition
1	Control System Engineering	Norman Nise	Wiley Publication	Seventh
2	Control System Engineering	I.J. Nagrath M. Gopal	New Age International Publication	Fifth
3	Modern Control Engineering	Ogata	Prentice Hall	Fifth
4	Feedback Control Systems	U. A. Bakshi& S. C. Goyal	Technical Publications	Second

Reference Books

Sr. No	Title	Author	Edition
1.	Automatic Control System	Kuo&Golnaraghi	Ninth
2.	Control Systems: Theory and Applications	SmarajitGhosh	Second
3.	Control Systems	N. C. Jagan	Third
4.	Feedback Control Systems	C.L. Phillips, R.D. Harbor	Fifth

Mapping of COs and POs

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	-	-	3	-	1	-	2	1	1	-
CO2	3	2	-	-	3	-	1	-	2	1	1	-
CO3	2	2	-	-	3	-	1	-	2	1	1	-
CO4	2	2	-	-	3	-	1	-	2	1	1	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur

Third Year (Sem.V) B. Tech. Electrical Engineering

PCC EE0358 AC Machines Lab

Teaching Scheme			**Examination Scheme**	
Lectures	--Hrs /week		**MSE**	--
Practicals	**02 Hrs/week**		**ISE/CA**	**25 Marks**
Total Credits	**1**		**ESE**	**25 Marks**

Prerequisite: Basic Electrical Engineering, Engineering Mathematics and Engineering Physics.

Course Objectives -

1 To conduct the experimental set of given circuits.

2 To design and test the electrical motor with control technique.

3 To study the voltage regulation methods.

Course Outcomes (CO)

Students will be able to

CO 1	Select proper electrical motor with control technique for required applications.
CO 2	Analyze the advanced control techniques applicable for AC and DC motors in practice.
CO 3	Design, develop and simulate advanced control schemes for electrical motors.

Course Contents

1. Performance characteristics of three phase IM by break load test.	CO 1	2 hrs
2. Equivalent circuit parameters of three phase induction motor by no load and block rotor test.	CO 1	2 hrs
3. Performances of three phase induction motor by Circle/ Lotus diagram	CO 1	2 hrs
4. Speed control of three phase wound induction motor by rotor resistance.	CO 2	2 hrs
5. To study and verify speed control of three phase induction motor from stator end.	CO 2	2 hrs
6. To study of different starters of the three induction motor.	CO 3	2 hrs
7. Determination of equivalent circuit parameters of single phase induction motor.	CO 2	2 hrs
8. Voltage regulation of three phase alternator by direct load test.	CO 3	2 hrs

9. Voltage regulation of three phase alternator by EMF method.	CO 2	2 hrs
10. Voltage regulation of three phase alternator by MMF method.	CO 3	2 hrs
11. To plot the V- Curves of synchronous motor.		
Submission:		
ESE	Minimum 8 experiments to be performed / simulated and evaluated in journal.	

Mapping of COs and POs

PO → CO ↓	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	**3**	**2**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO2	**3**	**2**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
CO3	**3**	**2**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**1**	**-**	**-**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur				
Third Year(Sem.–V) B. Tech. Electrical Engineering				
PEC EE039 Digital Protection Lab				
Laboratory Scheme:			**Examination Scheme**	
Lectures	--Hrs /week		**MSE**	--
Practical/Tutorials	**02 Hrs/Week**		**ISE/CA**	25 Marks
Total Credits	**1**		**ESE**	-

Pre-requisite-Electrical Machines, Basic Electronics / Analog Electronics, Measurements and Instrumentation

Course Outcomes (CO): After the successful completion of this course the student will be able to

CO1	Identify and understand the working of various protective relays and their characteristics used in power system protection.
CO2	Analyze the performance of overcurrent, directional, and distance relays through experimental characteristics and settings.
CO3	Apply protection schemes for power system equipment such as transformers, generators, and transmission lines using practical and simulation approaches.
CO4	Understand and implement digital protection concepts including signal conditioning, A/D conversion, MATLAB-based relay simulation, and modern protection systems like SCADA.

Experiment No.	Course Contents	CO
Experiment 1	**Study of Protective Relays** Identification and working of different types of relays used in power system protection.	**CO1**
Experiment 2	**Characteristics of Overcurrent Relay** Plot time-current characteristics and analyze relay settings.	**CO2**
Experiment 3	**Directional Overcurrent Relay Experiment** Study the operation and direction sensing of relay.	**CO2**
Experiment 4	**Distance Protection using Impedance Relay** Determine the operating characteristics of impedance relay.	**CO2**
Experiment 5	**Study of Reactance and Mho Relay** Compare characteristics and applications of different distance relays.	**CO2**
Experiment 6	**Differential Protection of Transformer (Simulation/Hardware)** Analyze working principle and fault detection.	**CO3**
Experiment 7	**Buchholz Relay Demonstration (Model/Video/Simulation)** Study internal fault protection of transformer.	**CO3**
Experiment 8	**Generator Protection Scheme Study** Study protection methods for alternators (overcurrent, differential, etc.).	**CO3**
Experiment 9	**Simulation of Digital Relay using MATLAB/Software** Implement basic digital protection logic (sampling, filtering).	**CO4**
Experiment 10	**A/D Conversion and Signal Conditioning Experiment** Study signal processing used in digital relays.	**CO4**
Experiment 11	**Circuit Breaker Characteristics Study** Study different types (SF_6, Vacuum, Oil) using models or simulation.	**CO4**
Experiment 12	**SCADA-based Protection System Demonstration** Study modern protection techniques and monitoring systems.	**CO4**

Minimum number of Experiments :10

Text Books	
1	Power System Protection and Switchgear by Badri Ram, D. N. Vishwakarma, Publisher: McGraw Hill
2	Switchgear Protection and Power Systems by Sunil S. Rao Publisher: Khanna Publishers
3	Fundamentals of Power System Protection by S. R. Bhide
4	Power System Protection and Switchgear: Principles and Applications by Chirag Gupta et al.
Reference Books	
1.	Digital Protection for Power Systems by Allan T. Johns, Salman K. Salman
2.	Practical Power System Protection by Hewitson, Brown, Balakrishnan
3.	Electrical Power System Protection by C. Christopoulos, A. Wright
4.	Power System Protection: Fundamentals and Applications by John Ciufo, Aaron Cooperberg

Shivaji University, Kolhapur

Third Year (Sem–V) B. Tech. Electrical Engineering

MDM EE0359 Electrical Machines Laboratory

Teaching Scheme			Examination Scheme	
Lectures	--Hrs/week		MSE	--
Tutorials	--Hrs/week		ISE/CA	50
Practical	2 Hrs/week		ESE	--
Total Credits	1			

Prerequisite:

Course Objectives:

To perform standard tests on AC machines and understand their operating principles.

To evaluate efficiency, losses, and speed regulation of induction motors and alternators.

To study performance characteristics of synchronous motors and AC machine starters.

To develop practical skills in measurement, analysis, and safe operation of electrical machines.

Course Outcomes(CO):

At the end of successful completion of the course, the student will be

CO1	Conduct no-load, blocked-rotor, short-circuit, and load tests on single-phase and three-phase AC machines.
CO2	Determine efficiency, losses, speed regulation, and voltage regulation of induction motors and alternators from experimental results.
CO3	Plot and interpret V and inverted-V curves of synchronous motors and explain power factor control.
CO4	Select and justify suitable starters for AC machines and follow safe laboratory practices while testing electrical machines.

	Course Contents	CO	Hours
1	No load test on three phase induction motor.	**CO1**	**2**
2	Blocked rotor test on three phase induction motor.	**CO1**	**2**
3	No load test on single phase induction motor.	**CO1**	**2**
4	Blocked rotor test on single phase induction motor.	**CO1**	**2**
5	Short circuit test on three phase alternator	**CO2**	**2**
6	Load test on alternator	**CO2**	**2**
7	V and inverted V curve of Synchronous motor.	**CO2**	**2**
8	Study of starters used for the AC machines.	**CO3**	**2**
9	Determination of efficiency & speed regulation of 3 phase slip ring induction motor by direct loading method.	**CO4**	**2**

10	Determination of efficiency & speed regulation of 1 phases induction motor.	**CO4**	**2**
11	Parallel operation of alternator.	**CO2**	**2**
References:			
Text Books			
1	Electrical Machines, S. K. Bhattacharya, Tata Mc-Graw-Hill publication		
2	Electrical Machines, I. J. Nagrath, D. P. Kothari, Tata Mc-Graw-Hill publication IV edition		
3	V. K. Mehta "Principles of Electrical Machines". S. Chand Publishers, New Delhi		
4	B. L. Theraja "A textbook of Electrical Technology" Volume II S. Chand Publishers, New Delhi		
Reference Books			
1	**Electrical Machinery by P. S. Bimhra** : coverage of induction motors (Units 1-2), synchronous motors (Unit 4), alternators (Unit 5)		
2	**Electric Machines by D.P. Kothari & I.J. Nagrath:** coverage of induction motors (Units 1-2), synchronous motors (Unit 4), alternators (Unit 5)		
3	**Special Electrical Machines by K.V. Bhadra, S. Gopalakrishnan, P.K. Pillai:** coverage of Advanced and Special Machines (Unit 6),		
4	Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab -'Signals & system' -IInd Edition - Pearson Education.		
5	**Electrical Machines, AshfaqHussain, DhanpatRai& Sons:** : coverage of induction motors (Units 1-2), synchronous motors (Unit 4), alternators (Unit 5)		

Mapping of Cos and POs

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	1	-	-	-	-	-	-	1
CO2	3	3	-	2	1	-	-	-	-	-	-	1
CO3	3	3	-	2	1	-	-	-	-	-	-	1
CO4	2	2	2	-	1	-	-	2	1	1	-	1

1:Slight(Low) 2:Moderate(Medium) 3:Substantial(High)

Shivaji University, Kolhapur

Third Year (Sem.–V) B. Tech. Electrical Engineering

EL EE03511 Minor Project 01

Teaching Scheme			**Examination Scheme**	
Lectures	--Hrs /week		MSE	--
Tutorials	--		ISE/CA	25 Marks
Practical	2 Hrs/week		ESE	--
Total Credits	1			

Prerequisite: Basic knowledge of electrical and electronic engineering fundamentals, problem-solving skills, and familiarity with simulation tools and technical report writing.

Course objectives.

To identify and formulate electrical engineering problems through literature survey and problem analysis.

To design and develop electrical/electronic systems, models, or simulations using appropriate engineering tools.

To develop teamwork, project management, and technical communication skills through effective collaboration and reporting.

Course Outcomes (CO): Students will be able to

CO1	Identify and formulate an Electrical Engineering problem through literature survey and problem analysis.
CO2	Design and develop an electrical/electronic system, model, or simulation using appropriate engineering tools.
CO3	Analyze experimental/simulation results and evaluate the performance of the proposed system.
CO4	Demonstrate ability to work effectively in a small team (maximum two students) and manage project tasks.
CO5	Prepare a technical report and presentation demonstrating engineering knowledge and communication skills.

Course Contents

- Project work can be a design project / experimental project / simulation project related to Electrical Engineering areas such as electrical machines, power systems, power electronics, control systems, renewable energy, electric vehicles, PLC/automation, embedded systems, or smart grid technologies.

- The project may consist of design, fabrication, simulation, testing, or analytical study of an electrical engineering system considering 2–3 technical factors identified during problem formulation.

- The project work shall be carried out in groups of maximum two students under the supervision of a faculty project guide.

- The project shall normally involve problem identification, literature survey, design or modelling, implementation/simulation, testing, and analysis of results.

- The project will include two reviews:

First Review: Assessment of project idea, literature survey, and progress of work.
Second Review: Final evaluation of implementation, results, report quality, and originality.
· Each group must present the project work and analysis results during the final evaluation.
· Students must prepare a project report under the guidance of the project guide.
· The report should include design drawings, circuit diagrams, block diagrams, simulation results, experimental setup details, bill of materials (BOM), and analysis results.
· One copy of the report shall be submitted to the project guide, and one copy shall remain with the project group.
Project Work Submitted by Students Shall Include
1. Work Diary
A work diary shall be maintained by the project group and verified weekly by the project guide.
The work diary should include:
a. Search and identification of suitable project topic.
b. Literature survey using journals, conference papers, research articles, books, and online technical resources.
c. Day-to-day activities carried out during the project work throughout the semester.
2. Synopsis
Each group must submit a project synopsis in the prescribed format:
a. Title of the Project.
b. Names of Students (Maximum 2 Students).
c. Name of Project Guide
d. Objective and Relevance of the Project
e. Present Theory and Existing Practices
f. Proposed Methodology / Proposed Work
g. Estimated Expenditure / Components Required
h. References
The synopsis should include minimum eight research papers or technical references.
The synopsis must be signed by both students, approved by the project guide, and endorsed by the Head of the Department.
3. Presentation and Report
· Each group must present the project work before faculty members and review committee during the review process.
· The final project demonstration and presentation will be part of the evaluation.
Minor Project Report Format
The project report should be 25–30 pages (typed on A4 sheets).

Standard Format:
1. Page Size: A4 (Trimmed)
2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches
5. Right Margin: 1.0 Inch
6. Font: Times New Roman, 12 pt
7. Line Spacing: 1.5
8. Page Numbers: Right aligned at footer (12 pt)
9. Headings: Times New Roman, 14 pt, Bold
References Format
• For Papers:
Author(s), "Title of Paper", Journal/Conference Name, Year.
• For Books:
Author(s), "Title of Book", Publisher, Edition, Year.

Mapping of COs and POs

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	1	1	-	-	-	-	1	-	2
CO2	2	2	3	2	3	-	-	-	1	1	-	2
CO3	2	3	2	3	2	-	-	-	-	1	-	2
CO4	-	-	1	-	-	-	-	-	3	2	1	1
CO5	-	-	-	-	1	-	-	-	2	3	1	1

1:Slight(Low) 2:Moderate(Medium) 3:Substantial(High)

Shivaji University, Kolhapur

Third Year(Sem.–VI)B. Tech. Electrical Engineering

PCC EE0361 Power Electronics

Teaching Scheme			Examination Scheme	
Lectures	03Hrs /week		**MSE**	30
Practical/Tutorials	-		**ISE/CA**	10
Total Credits	3		**ESE**	60
			Duration of ESE	2 Hours 30 Minutes

Course objectives.

1	To understand the fundamentals of power semiconductor devices and their characteristics.
2	To study the operation and analysis of various power electronic converters.
3	To evaluate the performance of power electronic circuits for different applications.
4	To develop the ability to design and implement basic power electronic systems.

Course Outcomes(CO):

CO1	Understand the operation and characteristics of power semiconductor switching devices.
CO2	Analyze the performance of single-phase and three-phase rectifier circuits.
CO3	Evaluate the working of phase-controlled AC to DC converters.
CO4	Analyze and design DC to DC converters for various applications.
CO5	Understand the operation and control of switch-mode DC to AC inverters.
CO6	Explain the working principles and applications of cycloconverters and matrix converters.

	Course Contents	CO	Hours
Unit1	**Power Semiconductor Switches.** Power diodes, Power transistor, MOSFET, IGBT and GTO, Study of the Firing Circuits for thyristor(SCR) , Comparison of GTO and IGBT, ,Comparative study of MOSFET, thyristor, GTO, BJT and IGBT.		**07**
Unit2	**Single phase and three phase Rectifiers .** Single phase half wave and single phase full wave diode bridge. Three phase half wave and three phase full wave diode bridge, Transformer power rating for above configurations waveforms of source current , DC current and output DC voltage waveforms.		**07**
Unit3	**Phase Controlled AC to DC Converters.** Classification of converters, Single phase half controlled and fully controlled thyristor converters, Three pulse and six pulse controlled converters, operation of converter with freewheeling diode. Effect of source inductance on the performance of the converter, overlap – angle. Performance factors for the converter such as displacement factor, distortion factor, total harmonic distortion, ripple factor and transformer utilization factor		**08**
Unit4	**DC to DC Converters.** Control of DC to DC converters, step down (buck) converter, Analysis of buck converter with RLE load, step up converter, buck – boost converter, full bridge DC to DC converter, concept of multiphase choppers, cuk converter.		**06**
Unit5	**Switch Mode DC – AC Inverters.** Basic concepts of switch mode inverters, single phase half bridge and full bridge inverter, three phase six step inverter, 120 degree mode of conduction, 180 degree mode of conduction, three phase PWM Inverter, sinusoidal PWM and selective harmonics elimination methods of PWM. Voltage and frequency control		**07**

Unit6	**Cyclo- converters and Matrix Converter.** Introduction to Single phase and three phase cyclo- converters. Working and topologies of Matrix converter, control methods, performance analysis of matrix converter. Applications of Cyclo- converters and Matrix Converter		**07**
Text Books			
1	H. Rashid "Power Electronics, Circuits, Devices and Applications", Pearson Education Inc., 3rd Edition.		
2	P. S. Bhimra, "Power Electronics", 2nd edition, Khanna Publishers References Books		
Reference Books			
1.	B.K. Bose, "Modern Power Electronics and A.C. Drives", Prentice Hall of India Pvt. Ltd. Publication.		
2.	Ned Mohan, Undeland and Robins, "Power Electronics, Converter Applications and Design", John Wiley and sons (Asia) Pvt. Ltd.		
3.	G. K. Dubey and Others "Thyristorised Power Controller", Wiley Eastern Ltd.		

Third Year (Sem–VI) B. Tech. Electrical Engineering				
PCC EE0362 Advanced Control System				
Teaching Scheme			**Examination Scheme**	
Lectures	03Hrs /week		**MSE**	30 Marks
Tutorials	1		**ISE/CA**	10 Marks
Total Credits	4		**ESE**	60 Marks
			Duration of ESE	2 Hours 30 Minutes

Prerequisite:

Course Objectives:

To understand advanced analysis techniques of control systems in time and frequency domains.

To develop mathematical models of dynamic systems using state-space representation.

To design and analyze control systems using classical and modern control methods with MATLAB.

Course Outcomes(CO): The student will be able to

CO1	Analyze control systems using time-domain and frequency-domain techniques
CO2	Evaluate stability and performance of control systems using root locus and Bode plot methods
CO3	Design compensators (lead, lag, lead-lag) using root locus and Bode diagram techniques to meet desired specifications
CO4	Design and tune PID controllers for improving system performance
CO5	Apply state-space techniques and Ackermann's formula for controller design

Unit No.	Course Contents	CO	Hours
Unit1	**Fundamentals of Control Systems and Classical Design Methods** Classical Control Design Techniques Compensation techniques –Lag, Lead, Lead-Lag Controllers design in frequency Domain, Design of PID control system.	**CO4**	**05**
Unit2	**Advanced Compensation Techniques using Root Locus Approach** Review of Root Locus, Cascade Lead compensation, cascade Lag compensation, cascade Lead-Lag compensation, Series and parallel compensation, Effect of addition of poles and zeros, Design of Lead compensation based on Root Locus approach, Design of Lag compensation based on Root Locus approach, Design of Lead-Lag compensation based on Root Locus approach, Root Locus of system with dead time.	**CO2**	**08**
Unit3	**Advanced Compensation Techniques using Bode Plot Approach** Review of Bode Plot, Stability of system from Bode Plot, Cascade Lead compensation, cascade Lag compensation, cascade Lead-Lag compensation, Design of Lead compensation based on Bode Plot, Design of Lag compensation based on Bode Plot, Design of Lead-Lag compensation based on Bode Plot	**CO3**	**08**
Unit4	**Advanced Digital Control System Analysis** State space representation of digital control system, Solving state space equation, Pulse transfer function.	**CO5**	**05**

Unit5	**Modern Control Design using State-Space Methods** Review of State Space, Controllability, Observability (Kalmans's test & Gilbert's test), Pole placement technique for controller design, Pole placement technique by Transformation method, Direct Substitution Method and by Ackermann's formula.	**CO5**	**08**
Unit6	**Digital Control Systems and Z-Transform Analysis** Review of Z-Transform, Z-Transform method for solving different equations, impulse sampling & data hold, pulse transfer function, stability analysis, transient & steady state analysis.	**CO1**	**08**

Text Books

Sr. No	Title	Author	Publisher	Edition
1	Control System Engineering	Norman Nise	Wiley Publication	Seventh
2	Control System Engineering	I.J. Nagrath M. Gopal	New Age International Publication	Fifth
3	Modern Control Engineering	Ogata	Prentice Hall	Fifth
4	Feedback Control Systems	U. A. Bakshi& S. C. Goyal	Technical Publications	Second

Reference Books

Sr. No	Title	Author	Edition
1.	Automatic Control System	Kuo&Golnaraghi	Ninth
2.	Control Systems: Theory and Applications	SmarajitGhosh	Second
3.	Control Systems	N. C. Jagan	Third
4.	Feedback Control Systems	C.L. Phillips, R.D. Harbor	Fifth

Mapping of COs and POs

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	1	2	3	-	-	-	-	-	-	-
CO2	3	3	2	2	3	-	-	-	-	-	-	-
CO3	3	2	3	2	3	-	-	-	1	-	-	-
CO4	3	2	3	2	3	-	-	-	1	-	-	-
CO5	3	3	3	2	3	-	-	-	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur				
Third Year(Sem.–VI) B. Tech. Electrical Engineering				
PCC EE0363 Power System Analysis				
Teaching Scheme			**Examination Scheme**	
Lectures	**3 Hrs/Week**		**MSE**	30 Marks
Practical/Tutorials	**….**		**ISE/CA**	10 Marks
Total Credits	**3**		**ESE**	60 Marks
			Duration of ESE	02 Hrs30Min

Prerequisite-

Electrical Power System Analysis requires basics of circuit theory, electrical machines, and electromagnetic concepts.

It also needs strong knowledge of mathematics, especially complex numbers, matrices, and differential equations

Course Outcomes(CO): After the successful completion of this course the student will be able to

CO1	Able to analyze symmetrical and unsymmetrical faults on power system.
CO2	Able to understand power flow in power system.
CO3	Able to understand concept of power system operation and control.

Unit No.	Course Contents	CO	Hours
Unit1	**Symmetrical Components and Sequence Networks-** Synthesis of Unsymmetrical Phasors, Symmetrical Components of Unsymmetrical Phasors, Power in Terms of Symmetrical Components, Sequence Circuits of a Symmetrical Transmission Line, Sequence Circuits of the Synchronous Machine, Sequence Circuits of Transformers, Unsymmetrical Series Impedances	**CO1**	**06**
Unit2	**Unsymmetrical Faults-** Unsymmetrical Faults on Power Systems, Single Line-to Ground Faults, Line-to-Line Faults, Double Line-to-Ground Faults, Open-Conductor Faults.	**CO1**	**08**
Unit3	**Power-Flow Analysis-** Power flow equations and solution techniques. Gauss-Seidal method, Newton-Raphson method, decoupled and fast decoupled methods, comparison of power flow methods, power flow simulation software.	**CO2**	**06**
Unit4	**Power System Stability**-Steady-state and transient stability concepts, rotor dynamics and swing equation, equal area criterion, step by step solution of swing curve, multimachine stability, factors affecting transient stability.	**CO3**	**06**
Unit5	**Load Frequency control**-Importance of load frequency control, frequency in multimachine system, determination of frequency in steady state, frequency dependence of loads, speed governors, governor characteristics, A.G.C.: objectives and implementation.	**CO3**	**08**
Unit6	**Reactive power compensation -** Production & absorption of reactive power, special compensation equipment: shunt capacitors, reactors, tap changing transformers, static VAR compensators.	**CO3**	**08**

Text Books

1	"Power System Analysis", Grainger John J and W D Stevenson Jr,Mc-Graw Hill, 2003 Edition
2	"Modern Power System Analysis", I. J. Nagrath, D. P. Kothari, (3rd Edition), Tata McGraw Hill Publishing Co. Ltd., 2003.

Reference Books

1.	"Power System Analysis and Design ",J. D. Glover and M. Sarma(5th Edition), Brooks/ Cole Publishing
2.	"Electric energy systems theory: An introduction",O. I. Elgerd, Tata McGraw Hill, 4th edition.

3.	"Power system analysis",HadiSaadat,3rd edition, McGraw Hill International publication,2016.
4.	Power system analysis", A. R. Bergen and Vijay Vittal, (2nd edition), Pearson Education Asia, 2001.
Useful Links	
1.	www.nptel.iitm.ac.in (NPTEL video Course Power system operation and control By A. N. Kulkarni IIT Bombay)
2.	www.nptel.iitd.ac.in (NPTEL video Course Power system stability and control by Prof. M.L. Kothari, IIT Delhi)

Mapping of CO and PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1.	2.	3.	4.					5.			6.
CO2	7.		8.	9.					10.			11.
CO3	12.	13.	14.	15.	16.	17.			18.			19.

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur

Third Year (Sem.–VI) B. Tech. Electrical Engineering

PEC-II EE0364 Power Plant Engineering

Teaching Scheme			Examination Scheme	
Lectures	03Hrs/week		**MSE**	30
Practical/Tutorials	--		**ISE/CA**	10
Total Credits	03		**ESE**	60
			Duration of ESE	02Hrs.30Min.

Prerequisite: Power system I, power system II, machine I and II

Course Outcomes(CO): After completion of this course, students will be able to

CO1	Analyze load characteristics, plant economics, and different conventional and non-conventional energy sources.
CO2	Explain the construction, working, and performance of thermal and nuclear power plants.
CO3	Understand the principles, components, and operation of hydroelectric power plants.
CO4	Evaluate the performance and applications of diesel engine and gas turbine power plants.
CO5	Analyze combined operation of power plants, tariffs, and economic aspects of power generation.
CO6	Understand grid interfacing, load sharing, and integration of different power plants.

	Course Contents	CO	Hours
Unit 1	**Fundamentals of Energy Resources and Power Plant Economics** Load and Energy survey, load duration curve, plant factor and plant economics, Introduction to conventional energy sources, different sources of non-conventional energy like solar, wind, tidal, geothermal, biomass, MHD plants, their applications and site selection, Indian energy scenario.	**CO1**	**08**
Unit 2	**Thermal and Nuclear Power Plants:** Thermal Power Station: Introduction, selection of sites, main parts of thermal power station and their working. Nuclear Power Plant: Review of atomic physics (atomic number, mass number, isotopes, atomic mass, unit rate of radioactivity, mass equivalent number, binding energy and mass defect), main parts of nuclear power station, types of reactors (pressurized water reactor (PWR), boiling water reactor, gas cooled reactor, liquid metal fast breeder reactor, heavy water reactor), plant layout and working, simple numerical, India's nuclear power program.	**CO2**	**07**
Unit 3	**Hydroelectric Power Plants** Hydroelectric Power Plant: Advantages and limitations, site, hydrological cycles and hydrographs, storage and pondage, essential elements of hydroelectric plant, classification, different types of turbines and their selection, governing of hydraulic turbines, surge tanks, draft tube, layout of hydro-station, simple numerical.	**CO3**	**07**
Unit 4	**Diesel and Gas Turbine Power Plants** Diesel Engine & Gas Power Plant: Advantages and limitations, types of diesel plants, general layout, IC engines and performance characteristics, layout of diesel engine power plant and applications. Components of gas power plant, gas turbine fuels, turbine fuels, turbine materials, working, improvement of thermal efficiency of gas power plant and applications, simple numerical examples.	**CO4**	**07**
Unit 5	**Economics and Combined Operation of Power Plants** Combined working of power plants: Economics of combined working power plants, base load and peak load stations, pumped storage plants, inter-connections of power stations. Tariff: Fixed cost, running cost and their interrelation for all types of conventional power plant, plant, depreciable cost, different types of tariffs, numerical examples.	**CO5**	**06**

Unit 6	**Grid Integration and Interconnection of Power Plants** Grid interface of different power plants: Concept of parallel operation of various generating sources and load sharing, need of interconnection between different power plants, concept of grid, importance of grid, requirement of grid, types of grid (in transmission and distribution system), conditions to interface different power plants to grid.	**CO6**	**07**
Reference Books			
1.	Uppal H. R. "Power Plant Engineering" (Eurasia publications)		
2.	Nag P. K. " Power Plant Engineering",(Tata McGraw Hill Publications)		
3.	Deshpande M. V. "Elements of Electrical Power Station Design" (Wheeler publications)		
4.	V. K. Mehta, "Power System", S Chand Pub		
5.	J. B. Gupta, "A course in Power System Engineering"		
6.	Arora and Domkundwar, "A course in Power Plant Engineering" (DhanpatRai& co., 5/e)		
7.	. R. K. Rajput, "Power Plant Engineering"		
Useful Links			
1.	https://onlinecourses.nptel.ac.in/noc26_me29/preview		
2.	https://onlinecourses.nptel.ac.in/noc26_ee59/preview		
3.	https://elearn.nptel.ac.in/shop/nptel/power-plant-engineering/?v=13b5bfe96f3e		

Shivaji University, Kolhapur

Third Year (Sem–VI) B. Tech. Electrical Engineering

PEC III EE0365 Restructured Power System

Teaching Scheme			Examination Scheme	
Lectures	03Hrs /week		**MSE**	30 Marks
Tutorials	….		**ISE/CA**	10 Marks
Practical	….		**ESE**	60 Marks
Total Credits	3		Duration of ESE	2 Hours 30 Minute

Prerequisite: Basic knowledge of power systems, electrical networks, and fundamental concepts of power generation, transmission, and distribution.

Course Objectives:

Understand the need for restructuring of Power Systems and generalize the functioning and planning activities of ISO.

Understand transmission open access pricing issues and congestion management.

Understand transfer capability and estimate the transfer capability of a small power system.

Course Outcomes(CO): Students will be able to

CO1	Identify, formulate and solve electrical engineering problems in the broad area like power systems and its economics.
CO2	Understand market models and mechanisms for electricity as a commodity.
CO3	Appreciate legal, financial and economic issues related with transmission congestion management, locational marginal pricing and ancillary management.
CO4	Appreciate issues like fairness and social welfare with reference to transmission system usage and loss allocation.
CO5	Appreciate the need of reforms in power sector with focus on Indian power sector

Unit No	Course Contents	CO	Hours
Unit1	**Overview of Restructured Power System** Regulation and Deregulation, Vertically Integrated and Deregulated power industry, Market models, Market Clearing Price (MCP), Independent System Operator (ISO), Role of ISO, Ancillary Service Management, Deregulation in Power Industry (Technical and Economic Issues)	**CO1**	**07**
Unit2	**Economic Considerations in Restructured Power System** Introduction, Consumer and Supplier behavior, Demand elasticity, Supply elasticity, Short-run and Long-run costs, various costs of production. Electricity pricing: Electricity pricing in Generation, Transmission and Distribution, Introduction to Marginal cost, opportunity Costs, Dynamic pricing mechanism (ABT), Price elasticity of demand, Tariff setting principles, Distribution tariff for H. T. and L. T. consumers	**CO2**	**07**
Unit3	**Global Models of Restructured Power System** Market Evolution and Deregulation in UK, USA, South America, Nordic pool, China, PJM ISO, and New York Market.	**CO3**	**06**
Unit4	**Indian Power Market Evolution** Electricity Act 2003 and various national policies and guidelines, Ministry of Power, Role of CEA, CERC, state ERC, Load Dispatch Centers etc., Implications of ABT tariff on Indian power sector, Introduction to Indian Power Exchange	**CO4**	**07**

Unit5	**Transmission Pricing and Congestion Management** Transmission price components, various transmission pricing mechanisms, Tracing of power, Network usage and Loss Allocation. Introduction to Congestion in Transmission network, methods of Congestion Management	**CO4**	**07**
Unit6	**OASIS** Introduction of OASIS, Structure of OASIS, Pooling of information, Transfer capability on OASIS and various concepts like ATC, TTC, TRM, and CBM	**CO5**	**06**

Text Books

Sr. No	Title	Author	Edition
1	Restructured electrical power systems: operation, trading and volatility	Mohammad Shahidehpour, MuwaffaqAlomoush	
2	Know Your Power	Sreekumar N, GirishSant	3rd

Reference Books

Sr. No	Title	Author
1.	Fundamentals of Power System Economics	Daniel Kirschen, GoranStrbac
2.	Operation of restructured power systems	Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen
3.	Power system economics: designing markets for electricity	Steven Stoft
4.	Making competition work in electricity	Sally Hunt
5.	Power System Restructuring and Deregulation	Loi Lei Lai

Mapping of COs and POs

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	2	-
CO2	2	2	-	-	-	-	-	-	-	-	3	-
CO3	2	3	-	-	-	1	-	-	-	-	3	-
CO4	2	2	-	-	-	1	1	2	-	-	2	-
CO5	1	1	-	-	-	2	-	2	-	-	3	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur

Third Year (Sem.VI) B. Tech. Electrical Engineering

Multi-disciplinary Minor–04 Power Electronics and Embedded System

Teaching Scheme			Examination Scheme	
Lectures	**02 Hrs./week**		**MSE**	30 Marks
Practical/Tutorials	….		**ISE**	10 Marks
Total Credits	**2**		**ESE**	60 Marks
			Duration of ESE	2 Hours 30 Minute

Prerequisite : Power electronic devices, controlled converters

Course Objectives: The objective of the course is to

1. This course intends to provide basic knowledge of different power electronic devices, rectifiers, converters, inverters and choppers.
2. It is aimed to impart skills of analysis for different types of converters such as rectifiers, controlled converters, inverters and choppers.
3. Make the students acquainted with design of different types of converters such as rectifiers, controlled converters, inverters, choppers and their associated control circuit
4. To introduce the architecture, components, and role of RTOS in embedded systems.
5. To develop skills in communication protocols and Arduino based Embedded C programming.
6. To apply embedded systems in real-world applications such as motor control, EV charging, IoT, and automation.

Course Outcomes(CO):At the end of successful completion of the course, the student will be:

CO1	Understand the operation and characteristics of power semiconductor devices (SCR, MOSFET, IGBT, etc.)
CO2	Analyze uncontrolled and controlled rectifier circuits
CO3	Analyze DC–DC converters and inverter circuits
CO4	Students will be able to analyze the structure and explain the functionality of embedded systems, including RTOS concepts.
CO5	Students will be able to implement UART, SPI, I2C, CAN, and USB interfaces using Embedded C on ARM-based microcontrollers (Arduino boards).
CO6	Students will be able to design and demonstrate embedded solutions for power and automation systems.

Unit No.	Course Contents	CO	Hours
Unit1	**Power Semiconductor Switches** Power semiconductor devices such as power diodes, transistor, MOSFET, IGBT and GTO, Study of the driver circuits for thyristor, GTO and IGBT, Comparative study of MOSFET, thyristor, GTO, BJT and IGBT.	**CO1**	**06**
Unit2	**Single phase and three phase Rectifiers** Single phase half wave and full wave bridge rectifiers. Three phase half wave and full wave bridge rectifier, Transformer power rating for above configurations waveforms of source current , DC current and output DC voltage waveforms .	**CO2**	**06**
Unit3	**DC to DC Converters** Control of DC to DC converters, step down (buck) converter, Analysis of buck converter with RLE load, step up converter, buck – boost converter, choppers, cuk converter.	**CO3**	**06**

Unit4	**Fundamentals of Embedded Systems** Introduction to embedded systems: definition, characteristics, and applications, Hardware components: microcontrollers, processors, memory, I/O devices (conceptual overview), Embedded system architecture – block diagram approach, Real-time operating systems (RTOS) – basic concepts	**CO4**	**05**
Unit5	**Embedded Interfacing & programming** Interfacing: UART, USART, SPI, I2C, CAN BUS, USB. Introduction to Arduino and Embedded C	**CO5**	**06**
Unit6	**Applications of Embedded System** Motor speed control (DC & Servo) using PWM, EV Charging System, IoT enabled power system, Smart Home Automation	**CO6**	**07**

Text Books	
1.	H. Rashid "Power Electronics, Circuits, Devices and Applications", Pearson Education Inc.
2.	3rd Edition. 2. P. S. Bhimra, "Power Electronics", 2nd edition, Khanna Publishers
3.	Raj kamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill.
4.	Muhammad Ali Mazidi, "Embedded Systems with ARM Cortex-M Microcontroller", Pearson.
Reference Books	
1.	B.K. Bose, "Modern Power Electronics and A.C. Drives", Prentice Hall of India Pvt. Ltd. Publication.
2.	Ned Mohan, Undeland and Robins, "Power Electronics, Converter Applications and Design", John Wiley and sons (Asia) Pvt. Ltd
3.	G. K. Dubey and Others "Thyristorised Power Controller", Wiley Eastern Ltd.
4.	Frank Vahid, "Embedded System Design: A Unified Hardware / Software Introduction", Wiley.
5.	Shibu K. V., "Introduction to Embedded Systems", McGraw Hill.
General Instructions: 1. Minimum number of assignments should be 6 covering all topics.	
Useful Link/NPTEL Course:	
1.	Power Electronics, IIT Delhi, Prof.G.Bhuvaneshwari
2.	Fundamental of Power Electronics, IISc Bangalore By Prof. L Umanand |
3.	Embedded System Design, IIT Kharagpur. Prof. AnupamBasu

Mapping of COs and POs

PO → CO ↓	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	**3**	**2**	**–**	**–**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**–**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO5	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO6	**2**	**2**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Shivaji University, Kolhapur

Third Year (Sem- VI) B.Tech. Electrical Engineering

PCC EE0367 Power Electronics Lab

Teaching Scheme			**Examination Scheme**	
Practical	02Hrs/week		MSE	--
Tutorials	-		ISE/CA	50 Marks
Total Credits	1		ESE	25 Marks
			Total Marks	75 Marks

Prerequisite: Fundamentals Electronics and Fourier Series Basics

Course Outcomes (CO): At the end of this course, student will be able to

CO1	Understand the fundamental concepts of SCR(Thyristor), its characteristics and Firing Circuits for SCRs
CO2	Analyze working of single phase & three Phase Phase uncontrolled Converters (Rectifiers) using diodes
CO3	Analyze working of single phase & three Phase Phase controlled Converters using SCRs
CO4	Understand working of Chopper circuits (DC-DC Converters)
CO5	Analyze the working of Series and Parallel inverter circuits
CO6	Understand single phase-Single Phase cycloconverters.

List of Experiments/Assignments

Exp.1	Study of VI characteristics of SCR
Exp.2	Study of Firing Circuits of SCR (R-firing and RC Firing circuits)
Exp.3	Study of Single Phase uncontrolled bridge rectifier using diodes.
Exp.4	Study of Single Phase controlled converter with R and RL Load
Exp.5	Study of DC-DC converters (type A and type B Chopper circuits)
Exp.6	Study of Series Inverter & Parallel Inverter
Exp.7	Study of Single phase – Single Phase cyclo-converter.

Text Books

1	H. Rashid "Power Electronics, Circuits, Devices and Applications", Pearson Education Inc., 3rd Edition.

2	P. S. Bhimra, “Power Electronics”, 2nd edition, Khanna Publishers
Reference Books	
1.	B.K. Bose, “Modern Power Electronics and A.C. Drives”, Prentice Hall of India Pvt.
	Ltd. Publication.
2.	Ned Mohan, Undeland and Robins, “Power Electronics, Converter Applications and
	Design”, John Wiley and sons (Asia) Pvt. Ltd.
3.	G. K. Dubey and Others “Thyristorised Power Controller”, Wiley Eastern Ltd.

Shivaji University, Kolhapur				
Third Year (Sem–VI) B. Tech. Electrical Engineering				
PCC EE0368 Advanced Control System Lab				
Teaching Scheme			**Examination Scheme**	
Lectures	….		**MSE**	….
Tutorials	….		**ISE/CA**	50 Marks
Practical	2 Hrs/week		**ESE**	25 Marks
Total Credits	1			

Prerequisite:

Course Objectives:

To understand and analyze the dynamic behavior of control systems using MATLAB

To evaluate system performance using time and frequency response techniques

To design and implement controllers for improving system performance

To model, simulate, and analyze control systems using MATLAB/Simulink tools

Course Outcomes(CO): At the end of successful completion of the course, the student will be

CO1	Analyze time response of control systems using MATLAB.
CO2	Evaluate stability and frequency response of control systems.
CO3	Apply state-space methods and controller design techniques.
CO4	Design and simulate digital and modern control systems using MATLAB.

Sr.No.	Course Contents	CO	Hours
1	Time Response Analysis of Higher Order Systems using MATLAB.	**CO1**	**02**
2	Analysis of Transient Response Characteristics using MATLAB.	**CO1**	**02**
3	Stability Analysis using Routh–Hurwitz Criterion in MATLAB.	**CO2**	**02**
4	Root Locus Analysis of Control Systems using MATLAB.	**CO2**	**02**
5	Frequency Response Analysis using Bode Plot in MATLAB.	**CO2**	**02**
6	Stability Analysis using Nyquist Plot in MATLAB.	**CO2**	**02**
7	Design and Simulation of PID Controller using MATLAB/Simulink.	**CO3**	**02**
8	State Space Modeling of Dynamic Systems using MATLAB.	**CO3**	**02**
9	Controllability Analysis using State Space Representation in MATLAB.	**CO3**	**02**
10	Observability Analysis using State Space Representation in MATLAB.	**CO3**	**02**
11	Discrete Time System Analysis using MATLAB.	**CO4**	**02**
12	Simulation of Modern Control Systems using MATLAB/Simulink.	**CO4**	**02**

Text Books

Sr. No	Title	Author	Publisher	Edition
1	Control System Engineering	Norman Nise	Wiley Publication	Seventh
2	Control System Engineering	I.J. Nagrath M. Gopal	New Age International Publication	Fifth

3	Modern Control Engineering	Ogata	Prentice Hall	Fifth
4	Feedback Control Systems	U. A. Bakshi& S. C. Goyal	Technical Publications	Second
Reference Books				
Sr. No	**Title**		**Author**	**Edition**
1.	Automatic Control System		Kuo&Golnaraghi	Ninth
2.	Control Systems: Theory and Applications		SmarajitGhosh	Second
3.	Control Systems		N. C. Jagan	Third
4.	Feedback Control Systems		C.L. Phillips, R.D. Harbor	Fifth

Mapping of COs and POs

PO →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO↓												
CO1	3	2	1	2	3	-	-	-	-	-	-	1
CO2	3	3	2	2	3	-	-	-	-	-	-	1
CO3	3	2	3	2	3	-	-	-	1	-	-	1
CO4	3	2	3	2	3	-	-	-	1	1	-	2

1: Slight (Low)2: Moderate (Medium)3: Substantial (High)

Third Year (Sem–VI)B. Tech. Electrical Engineering				
EL EE0369 Minor Project 02				
Teaching Scheme			**Examination Scheme**	
Lectures	--		MSE	--
Tutorials	--		ISE/CA	50 Marks
Practical	04 Hrs/week		ESE	--
Total Credits	2			

Prerequisite: Basic knowledge of core engineering concepts, problem-solving skills, and familiarity with design tools and project development methodologies.

Course objectives.

To enable students to identify and solve real-world electrical engineering problems.

To develop skills in designing and implementing electrical systems using modern tools.

To enhance practical knowledge in areas like power systems, control, PLC, or renewable energy& etc.

To promote teamwork (maximum 2 students per group) and effective project management.

To improve technical documentation, presentation, and communication skills.

Course Outcomes (CO): Students will be able to

CO1	Identify and formulate real-world electrical engineering problems.
CO2	Design and develop electrical systems using appropriate tools and techniques.
CO3	Apply theoretical concepts to implement practical solutions in areas like power, control, or electronics.
CO4	Demonstrate teamwork (maximum 2 students per group) and effective project execution skills.
CO5	Prepare technical documentation and present project outcomes professionally.

Course Contents

1. Project Guidelines:

- The project work may be a design / experimental / simulation / analytical project related to Electrical Engineering domains such as electrical machines, power systems, power electronics, control systems, renewable energy, electric vehicles, PLC/automation, embedded systems, or smart grid technologies.

- The project may involve design, fabrication, simulation, testing, or analytical study of an electrical system considering 2–3 technical parameters identified during problem formulation.

- The project shall be carried out in a group of maximum two students under the supervision of a faculty project guide assigned by departmental Project Coordinator.

2. The project should typically include:
• Problem identification
• Literature survey
• Design / modelling
• Implementation / simulation (Or any Software Analysis)
• Testing and result analysis
3. Project Reviews:
• First Review:
Evaluation of project title, problem definition, literature survey, and initial progress.
• Second Review:
Final assessment based on implementation, results, report quality, and originality.
• Each group must present their project work and analysis results during evaluations.
4. Project Report Submission:
• Students must prepare a project report under the guidance of the project guide.
5. The Report should include:
• Block diagrams and circuit diagrams
• Design details and drawings
• Simulation results / experimental setup (Software Analysis & Hardware Analysis)
• Bill of Materials (BOM)
• Result analysis and conclusions
• Submit One hard copy to the department.
6. Work Diary
• A work diary must be maintained and verified weekly by the project guide.
It should include:
• Selection and finalization of project topic
• Literature survey (journals, research papers, books, online resources)
• Weekly progress and day-to-day project activities
7. Project Synopsis
Each group must submit a synopsis in the prescribed format:
• Title of the Project
• Number of Students (Maximum 2)
• Name of Project Guide
• Objectives and relevance of the project
• Existing system / theory / literature review
• Proposed methodology / work plan
• Estimated cost / components required
• References

• Minimum 5 to 6 references (journals, conference papers, etc.) must be included
• Synopsis must be signed by students, project guide, and endorsed by the Head of Department and Project Coordinator.
8. Presentation and Report
• Each group must present the project during review stages.
Final evaluation includes:
• Project demonstration
• Presentation (PPT/Poster)
9. Report Format
• **Length:** 25–30 pages (A4 size)
10. Formatting Guidelines:
• Page Size: A4
• Top Margin: 1.0 inch
• Bottom Margin: 1.0 inch
• Left Margin: 1.25 inches
• Right Margin: 0.75 inch
• Font: Times New Roman, 12 pt
• Line Spacing: 1.5
• Page Numbers: Footer, right aligned (12 pt)
• Headings: 14 pt, Bold
11. References Format
• **For Research Papers:**
Author(s), "Title of Paper", Journal/Conference Name, Year.
• **For Books:**
Author(s), "Title of Book", Publisher, Edition, Year.

Mapping of CO and PO

PO → CO↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	2	2	1	-	-	-	-	-	-	1
CO2	2	3	3	2	3	-	-	-	-	-	1	1
CO3	3	2	2	3	2	-	-	-	-	-	-	1
CO4	-	-	1	-	-	-	-	-	3	2	3	1
CO5	-	-	-	-	-	-	-	-	2	3	1	1

1: Slight (Low) 2:Moderate (Medium) 3:Substantial (High)