# College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

## Department of Electrical Engineering

## Curriculum Structure & Detailed Syllabus (UG Program)

## Second Year B.Tech.

(Revision: A.Y. 2015-16, Effective from: A.Y. 2016-17)

**INDEX**

# UG PROGRAMS
## (FOR AWARD of B.TECH.DEGREE)

# ACADEMIC RULES and REGULATIONS

**1. Short Title and Commencement:**

(a) These Regulations shall be called the "College of Engineering, Pune Regulations for the Award of B.Tech. Degree";

(b) They shall come into effect from the date of getting approval from the Board of Governors of the College.

(c) They shall be applicable for students enrolling for B. Tech. Degree programmes at the College during the year 2007-08.

**2. Definitions:**

(a) "B. Tech." means Bachelor of Technology, an Under Graduate Degree awarded by and from the University;

(b) "Board" means Board of Governors of the college;

(c) "College" means College of Engineering, Pune;

(d) "Council" means All India Council for Technical Education;

(e) "Dean" means Dean of the College, with the specific functions also indicated along with the title;

(f) "Deputy Director" means Deputy Director of the College;

(g) "Director" means Director of the College;

(h) "Government" means Government of the Maharashtra;

(i) "Prescribed" means prescribed by these or any other Regulations of the College;

(j) "Regulations" means College of Engineering, Pune Regulations for the Award of B. Tech. Degree;

(k) "Senate" means Senate of the College;

(l) "University" means Savitribai Phule Pune University

**3. Preamble:**

The Regulations prescribed herein have been made by the College, an autonomous institution affiliated to the Savitribai Phule Pune University, to facilitate the smooth and orderly conduct of its academic programmes and activities at the B. Tech level. It

is expected that the Regulations will enable the students to take advantage of the various academic opportunities at the College and prepare themselves to face the challenges in their professional careers ahead. It may be noted that:

(a) The provisions made herein shall be applicable to all the B. Tech. Programmes offered at the College, at present;

(b) They shall also be applicable to all the new B. Tech. Programmes which may be started at the College in the future;

(c) Academic and non-academic requirements prescribed by the Senate have to be fulfilled by a student for eligibility to the Award of B.Tech. degree.

## 4. Academic Calendar:

**Table 1: Suggested Breakdown of Academic Year into Semesters**

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| 1. No. of Semesters/ Year | Three; Two being Main Semesters (Odd and Even) and One being a Supplementary Semester;<br>(Note: Supplementary Semester is primarily to assist weak and/or failed students through make up courses, wherever possible. However, the College may use this Semester to arrange Add-On Courses for other students and/or for deputing them for practical training elsewhere.) |
| 2. Semester Durations: | Main Semesters: 19 Weeks each;<br>Supplementary Semester: 8 Weeks; |
| 3. Academic Activities (Weeks): | Main Semester (Odd or Even)<br>Registration of Courses- 0.5; Course work- 15.5; Examination Preparation-1.0; Examinations- 1.0; Declaration of Results- 1.0; Total: 19;<br>Supplementary Semester (only for make up Courses): Registration of Courses- 0.1; Course Work- 7.0;<br>Examination Preparation-0.2; Examinations- 0.2; Declaration of Results- 0.5; Total: 8;<br>Inter-Semester Recess:<br>After each Main Semester- 2; After Supplementary Semester- 2;<br>Total: 14 (for good students) and 6 (for weak students)<br>*(Note: In each Semester, there shall be provision for students for Registration of Courses at the beginning, Dropping of Courses in the middle under the advice of Faculty Members and approved by Departmental Undergraduate Programme Committee (DUPC).* |

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| 4. Examinations: | Continuous Internal Evaluation (CIE) and Semester End Examination (ESE), both having equal weightage in the students' performance in Course Work/Laboratory Work and other activities;<br>(Note: The CIE shall be conducted throughout the Semester on dates announced in advance by the subject teacher, and its results made known to the students from time to time. This would be of help to the students to decide on Dropping or Withdrawal from Courses in consultation with their Advisors. However, the dates for the Mid-Semester Examination (MSE) which is a part of the CIE and ESE shall be fixed at the College level. |
| 5. Other Items: | • Care shall be taken to ensure that the total number of days for academic work are > 180/year;<br>• Academic schedules prescribed shall be strictly adhered to by all the Departments;<br>• Supplementary Semester shall be mainly for Make up Courses, to benefit weak or failed students to the extent possible;<br>• Students failed in a course shall attend a Course fully when it is offered again, and appear for all components of evaluation;<br>• Specified Min. /Max. Course load per Semester shall be followed at all times. |

(a) Each academic year shall be divided into two main semesters, each of 19 weeks, viz., odd semester (Jul. – Dec.) and even semester (Dec. – Apr.), and an 8-week supplementary semester (Apr.-Jun.).

(b) The College shall arrange regular academic activities for the students during the two main semesters and makeup and other courses for the students during the supplementary semester;

(c) The academic activities in a semester shall normally include course registration, course work, continuous internal evaluation, dropping/withdrawal from courses, semester-end examination, and declaration of results.

(d) The College shall announce the schedule for all the academic activities well before the commencement of the academic year and take all the necessary steps to follow them scrupulously.

(e) The college shall also announce adequate intra-semester and inter-semester breaks for the students and ensure that a minimum of 180 academic working days are available during the academic year.

(f) A typical breakdown of the academic year for the B. Tech programme at the College shall be as suggested in Table 1:

## 5. Admissions:

(a) The intake capacity of each programme, including the number of seats to be reserved for students of different categories shall be decided by the Board by following the Government directives and Council approvals.

(b) Admissions to the first year of all the programmes shall be made before the start of each academic year, through the Maharashtra Combined Entrance Test (MHCET) conducted by the Government.

(c) The College shall also admit to first year of the programmes, a limited number of students of Non-Resident Indian (NRI), Persons of Indian Origin (PIO) and Foreign National categories, as per Government rules.

(d) There shall also be a merit-based, lateral admission of students having Diploma qualification to the second year of all the programmes at the College in accordance with the Government rules applicable for such admissions.

(e) The College reserves the right to revoke the admission made to a candidate, if it is found at any time after admission that he/she does not fulfill all the requirements stipulated in the offer of admission.

(f) The College also reserves the right to cancel the admission of any student and discontinue his/her studies at any stage of studentship for unsatisfactory academic performance and/or undisciplined conduct.

## 6. In-campus Residence:

(a) Interested students may apply for hostel accommodation at the time of admissions, as the College is partially residential and it can admit a limited number of men and women students in the hostels.

(b) The method of admission to students' hostels, rent payable per each seat allotted and the discipline to be followed by the residents shall be governed by "rules and regulations" framed by the College in this behalf.

(c) Each student selected for hostel admission shall be provided a seat in one of the hostel rooms identified for this purpose and there shall be no family accommodation available in the hostel for married students.

(d) Students residing in the hostels shall adhere to the prescribed hostel discipline and pay the hostel/mess charges regularly, as any failure to do so, may lead to withdrawal of hostel facilities to such students.

(e) Hostel residents shall apply for leave of absence and get the same approved before leaving the hostel even for a few days, as any failure to do so may lead to cancellation of hostel admission to such students.

(f) Students residing in the hostels shall be required to clear all the hostel dues and vacate their rooms at the end of each academic year, as they will be considered for hostel admission afresh for the New Year.

## 7. Attendance:

(a) Each student shall be required to attend at least 75 per cent of all the classes arranged like, lectures, tutorials, laboratories, studios and workshops for being permitted to attend the semester-end examination.

(b) Extra Academic Activities (EAC) like Yoga, NSS, Physical Training, NCC and, Boat Club shall be compulsory for students of the first year, with at least a minimum attendance of 75 percent in each of them.

(c) Students shall also be required to take part in any other academic and non-academic activities and attend the camps, as and when arranged by the College during the academic year.

(d) Students desirous of leave of absence for less than two weeks during a semester shall apply for it in advance to the Head of the Department giving reasons & supporting documents, if any and get it approved.

(e) Absence due to illness or any other reason for a period less than two weeks in a semester, for which a student could not make prior application, may be condoned by the Head of the Department after proper verification.

(f) The Dean, Academic Affairs shall be the Authority for sanctioning the leave of students outside clauses (4) and (5) above, after receiving their applications along with recommendations of the Heads of Departments.

(g) In the case of long absence of a student in a semester with prior approval or otherwise, the Dean, Academic Affairs shall decide whether the student be asked to withdraw from the programme for that particular semester.

(h) In all the cases of leave of absence as per Clauses (4)-(6) above, the period of leave taken shall not be condoned for the purposes of fulfilling the attendance requirements stipulated in the Clauses (1) and (2).

(i) It shall be the responsibility of a student residing in the hostel to intimate the Warden of his/her hostel and also the concerned course instructors regarding his/her absence before proceeding on leave.

## 8. Code of Conduct and Discipline:

(a) All students shall be required to conduct themselves in a manner befitting the students of a national institution of high reputation, within and outside the precincts of the College.

(b) Unsocial activities like ragging in any form shall not be permitted within or outside the precincts of the College and the students found indulging in them shall be dealt with severely and dismissed from the College.

(c) The following additional acts of omission and/or commission by the students within or outside the precincts of the College shall constitute gross violation of code of conduct punishable as indiscipline:

i. Lack of courtesy and decorum, as well as indecent behaviour;
ii. Willful damage of property of the College/Hostel or of fellow students;
iii. Possession/consumption/distribution of alcoholic drinks and banned drugs;

iv. Mutilation or unauthorized possession of library material, like. books;

v. Noisy and unseemly behaviour, disturbing peace in the College/Hostel;

vi. Hacking in computer systems, either hardware or software or both;

vii. vii. Any other act considered by the College as of gross indiscipline.

(d) In each case above, the punishment shall be based on the gravity of offence, covering from reprimand, levy of fine, expulsion from Hostel, debar from examination, rustication for a period, to outright expulsion.

(e) The reprimanding Authority for an offence committed by students in the Hostels and in the Department or the classroom shall be respectively, the Rector of the Hostels and the Head of the concerned Department.

(f) In all the cases of offence committed by students in jurisdictions outside the purview of Clause (5), the Dean, Students Affairs shall be the Authority to reprimand them.

(g) All major acts of indiscipline involving punishment other than mere reprimand, shall be considered and decided by the Chairman, Students Disciplinary Committee appointed by the Senate.

(h) All other cases of indiscipline of students, like adoption of unfair means in the examinations shall be reported to the Dean, Academic Affairs, for taking appropriate action and deciding on the punishment to be levied.

(i) In all the cases of punishment levied on the students for any offence committed, the aggrieved party shall have the right to appeal to the Director, who shall constitute appropriate Committees to review the case.

## 9. Change of Branch:

(a) Change of branch shall be permissible for a limited number of special cases in the third semester as per following regulations.

(b) Only those students who have completed the common credits required in the first two semesters in their first attempt with a minimum CGPA of 8.5 shall only be eligible for making application for a change of branch.

(c) There shall be a maximum number of only two students admitted in any discipline in the third semester through the branch change rule.

(d) Intending students eligible for change of branch shall apply for the same to the Office of Academic Affairs of the College before the closing date notified at the beginning of odd semester of each academic year.

(e) Such students shall be required to indicate up to three branches, in order of preference to which they wish to change over, as the change shall be strictly based on their merit, subject to availability of vacancies.

(f) The change of branch shall be permitted purely on inter-se merit of all the eligible applicants. The CGPA of students at the end of the second semester shall be considered for rank ordering of the applicants seeking change of branch and in the case of a tie, the MHCET ranks shall also be considered.

(g) All the changes of branch permitted for intending students as per the above clauses

shall be effective from their third semester only and no further change of branch shall be permitted after this.

(h) All the changes of branch permitted at this stage shall be final and binding on the applicants and no student shall be permitted, under any circumstances, to refuse the change of branch offered.

(i) The candidates who have sought admission under Tuition Fee Waiver Scheme are not eligible for the branch change.

## 10. Course Structure:

a) Each course offered in the B. Tech. curriculum at the College shall be listed by using a total of five/six digits, the first two being letters and the remaining being numerals, as follows:

i. The first two letters to represent the Department offering the Course in abbreviated form, e.g., CE for Civil Engineering;

ii. The first numeral that follows to represent the year of the programme, such as 1, 2, 3 and 4, leading to 100,- 400 series;

iii. The next two numerals to represent the Course Number allotted for the subject by the Department, i.e., 01, 02, 03, up to 99;

iv. Thus, as an example, courses offered at the Department of Civil Engineering could be listed from CE 101 up to CE 499;

b) All the courses in the B. Tech. Curriculum shall be unitized, with one credit being assigned to each unit of course work, after the student completes its teaching-learning process successfully.

c) The assignment of credits to course work shall follow the well accepted practice at leading institutions, with one credit being defined to mean:

1. Lecture course conducted for one hour per week in a semester;

2. Tutorial conducted for one hour per week in a semester;

3. Laboratory/Practical conducted for two/three hours per week in a semester;

4. Project work conducted for two hours per week in a semester;

d) Each student for the B. Tech, Degree award shall be required to earn a total of 180 credits during his/her studentship at the College. While a student can register for more than 180 credits at the College, only 180 credits shall be reckoned for the Degree award. On the other hand, a student having less than 180 credits shall have to earn the remaining credits to make up the total to 180 credits so as to qualify for the Degree award. The total number of credits earned to complete the course depends on the academic schema for which the student has enrolled for.

e) In addition to the credit requirement prescribed above for the Degree award, each student shall have to complete the requirements of Extra Academic Activities (EAA) as referred to earlier in Clause 2 of Section 7, during the first two semesters of the programme. All the students shall receive certification as PP (for Passed), and NP (for not passed) in EAA, in the Grade Card. While obtaining certification as PP is a mandatory requirement for the Degree award of a student, this shall not be taken

into account for computing the final Grade Point Average.

1. Each student shall register for an average of 22 credits per semester during his/her studentship at the College, with the minimum and maximum credits being fixed as 16 and 28 credits per semester respectively. The exact number of credits to be registered by a student in a semester in a particular Department shall be decided by his/her Faculty Advisor based on the student's academic performance in the preceding semester and approval by the Departmental Undergraduate Programme Committee (DUPC).
2. The medium of instruction for course work and examinations at the College shall be English. The course work for the Programme shall be broadly divided into SEVEN main subject groups, as follows:
    - Humanities, Social Sciences and Management Courses;
    - Engineering Foundation Courses
    - Basic Sciences including Mathematics;
    - Mandatory Learning & Liberal Learning Courses;
    - Professional Core and Elective Subjects;
    - Skill based Laboratory Courses
    - Mini and Major Project
3. The total course package for the Programme at a Department shall have the following components:
    - Institutional Core subjects
    - Departmental Core subjects
    - Departmental Elective subjects
    - Other Elective subjects

f) The DUPC shall be responsible for planning the curriculum and syllabi for all the courses included for the Programme for approval by the Senate However, the Institutional Undergraduate Programme Committee (IUPC) shall be in charge for College wide implementation of course work, time tables and related requirements for the Programme.

g) Each Department shall have the flexibility to include industrial training and/or field work of 8 weeks for all its students as a compulsory requirement for the Degree award and this can be assigned credits, as approved by the Senate. However, these shall be arranged during the supplementary semester period following the sixth semester of studies at the College.

h) Each Department shall assign Faculty Advisors for all its students in consultation with the Dean, Academic Affairs and Dean, Students Affairs. It shall be the responsibility of the Faculty Advisors to help the students in planning their course work and other academic activities at the Department and also to regularly monitor and advise them on their academic and other performance at the College. For students of the first two semesters in any Department, the Dean, Students Affairs may assign Faculty Advisors from among the faculty of Basic Science including Mathematics and HSS Departments.

## 11. Course Registration for the Semester:

(a) Each student shall be required to register for course work by following the advice of the Faculty Advisor at the commencement of each semester on the day fixed for such registration and notified in the Academic Calendar.

(b) Students who fail to register for course work on the notified day may be permitted by the Department for late registration on another day announced in the Academic Calendar after payment of an additional fee fixed by the College.

(c) Only those students shall be permitted to register for course work who have:

i. Cleared all dues of the College, Hostel and Library including fines (if any) of the previous semester,

ii. Made all the required advance payments towards the College and Hostel dues for the current semester before the closing date, and

iii. Not been debarred from registration of courses on any other specific ground.

(d) Each student shall fulfill the following conditions at the time of registration of course work in any semester:

i. Each student of the first year shall register for all the courses in the first two semesters, with flexibility to drop one/two courses up to the minimum permissible limit of 18 credits in each case. Similarly Direct Diploma students will also register for all courses in third and fourth semester.

ii. A student shall be permitted to register for more than the average course load, i.e., up to a maximum of 28 credits, if he/she has shown outstanding performance in course work in the previous semesters, i.e., CGPA>=8.0.

iii. On the other hand, a student whose performance is not so good in the preceding semesters, i. e., =<5.0, shall be permitted to register 18 credits, the students who have secured CGPA in between 5 and 6 are allowed for normal credits ( i.e. The credits offered by the department in that semester) and the students who have secured more than 6 CGPA are allowed to register for one additional course. The students are mandatorily required to register for backlog subjects first. The faculty advisor is required to check for the pre-requisites if any at the time of registration.

(e) All the students shall note the following special features of the credit system, which shall be strictly followed at the College:

i. There shall be no re-examination facility as in the conventional academic system and ESE shall be conducted for the course once in a semester, except to meet the needs of students specially permitted by the College.

ii. A student shall have to re-register in all the failed courses (i.e., Getting Grade FF) at any further semester when they are offered again, freedom being given to the student to change the course only if it is an elective.

iii. Also, a student getting certification as NP in the Extra Academic Activities

(EAC), shall re- register for them in a following semester/s until he/she obtains certification as PP.

(f) A student shall have the possibility to drop a course in the middle of a semester as per the Academic Calendar, without mention in the Grade Card, with the concurrence of the Faculty Advisor, and after intimating the concerned course instructor/s and the academic section. However, it shall not be possible for a student to register for an alternative course in that semester.

## 12. Supplementary Semester:

(a) Departments shall have the flexibility to conduct supplementary semesters during summer months for FY B.Tech backlog subjects, as per the Academic Calendar. Such a semester shall be offered on the recommendation of DUPC and with the approval of the Dean, Academic Affairs. A student shall be allowed to register for a maximum of three subjects in a supplementary semester.

(b) The supplementary semester shall be utilized primarily to facilitate the failed students to attend **the FY courses in which they have failed and not for launching any new courses for credit.** However, a Department shall be free to arrange any Add-On courses for its students during this semester.

(c) The academic activity in the supplementary semester shall be at double the rate as compared to a normal semester; e.g., 1 credit of course work shall require two hours/week in the class room, so that the contact hours are maintained the same as in a normal semester. It shall also be necessary to fulfill the requirements of CIE and ESE for all the courses like in a normal semester.

(d) Courses planned for the supplementary semester shall be announced by the Dean, Academic Affairs in each year, well before the conclusion of the even semester. Students intending to avail of this facility shall have to register for the courses offered by paying the prescribed fees within the stipulated time.

(e) It shall be the responsibility of the Department to plan in advance the faculty and non-teaching staff requirements to conduct the supplementary semester and take necessary steps including the institutional approvals for organizing the same.

(f) The student who are either dropped or detained in the course/s during regular semester is not allowed to register for that course/s in summer.

(g) Re-exam (ONLY for 60 marks equivalent to end semester exam) shall be conducted for all other classes three weeks after grade approval by DUPC/DPPC. The re exam shall be conducted after every semester, for the subjects offered in that semester. For final grading, T1, T2 scores of respective semester shall be used. Grade ranges shall be same as that of regular semester for that subject

## 13. Programme Duration:

(a) The Programme duration for a student to complete the academic and other requirements at the College and qualify for the award of Degree by the University shall be normally 8 semesters.

(b) However, it shall be possible for an outstanding student to qualify for the Degree award in less than eight semesters, by registering for more number of credits i.e., up to the maximum permissible limit of 28 credits per semester from the third semester onwards to complete the Programme requirements of 180 credits. In such a case, the College shall issue a Provisional Certificate to the student who shall await the completion of eight semesters for the Degree award by the University.

(c) This flexibility shall also enable academically weaker students to conduct their studies at a slower pace and complete their Degree requirements in more than eight semesters. The maximum duration for the course completion will be 12 semesters.

(d) Clause (3) above shall be applicable to two types of students at the College:

i. Those wishing to complete the Degree requirements comfortably without encountering failure in any course;

(e) In both the above cases, a student shall have to complete the Programme requirements for the Degree of 180 credits within 12 semesters. Failure to complete the Programme requirements by any student in this period shall lead to the cancellation of his/her admission to the College forthwith. The Senate on case to case basis on the recommendations of the Director and Dean-Academics can extend the term.

(f) A student will not be awarded degree if his/her CGPA at the end of the course is less than 5. For such students the performance improvement scheme is recommended wherein he/she is eligible to take any three subjects for the improvement.

## 14. Temporary Withdrawal:

(a) Student shall be permitted to withdraw temporarily from the College on the grounds like prolonged illness, grave calamity in the family or any other serious happening. The withdrawal shall be for periods which are integral multiples of a semester, provided that

i. He/She applies to the College within at least 6 weeks of the commencement of the semester or from the date he/she last attended the classes, whichever is later, stating fully the reasons for such withdrawal together with supporting documents and endorsement of his/her guardian.

ii. The College is satisfied that, even by taking into account the expected period of withdrawal, the student has the possibility to complete the Programme requirements of 180 credits within the time limits specified earlier.

iii. The student shall have settled all the dues or demands at the College including those of Hostel, Department, Library and other units.

(b) A student availing of temporary withdrawal from the College under the above provision shall be required to pay such fees and/or charges as may be fixed by the College until such time as the students name appears on the Roll List. However, it shall be noted that the fees/charges once paid shall not be refunded.

(c) Normally, a student shall be entitled to avail of the temporary withdrawal facility only once during his/her studentship of the Programme at the College.

## 15. Termination from the Programme:

A student shall be required to leave the College on the following grounds

i. Absence from classes for more than six weeks at a time in a semester without leave of absence being approved by the competent authorities, shall result in the student's name being struck off the College rolls.

ii. Failure to meet the standards of discipline as prescribed by the College from time to time shall also result in the student being recommended by the Students Disciplinary Committee to leave the College.

## 16. Performance Assessment:

(a) There shall be achievement testing of all the students attending a course, like lecture course, laboratory/design/drawing course or a combination of the two. This shall be in two parts, as follows, both of them being important in assessing the students performance and achievement in the particular course:

1. Sessional, involving Continuous Internal Evaluation (CIE), to be normally conducted by the subject teacher all through the semester; This shall include mid-term tests, weekly/fortnightly class tests, home work assignments, problem solving, group discussions, quiz, seminar, mini-project and other means. The subject teacher shall announce the detailed methodology for conducting the various segments of CIE together with their weightages at the beginning of the semester.
2. Terminal, often designated as End Semester- Examination (ESE), to be conducted by the subject teacher, preferably jointly with an external examiner; This shall include a written examination for theory courses and practical/design/drawing examination with built-in oral part for laboratory/ design/drawing courses.
3. Both CIE and ESE shall have equal (50:50) weightage. A student's performance in a subject shall be judged by taking into account the results of CIE and ESE together.
4. The evaluation of the project work shall be based on Sessional Work assigned by the project supervisor, seminar presentation, project report and assessment by Project Evaluation Committee, as covered in Clause(7) later in this Section.
5. In the case of other requirements, such as, seminar, comprehensive viva voce and EAA the assessment shall be made as determined by the Grade Awarding Authority of the College.
6. While the conduct of CIE for a course shall be the responsibility of the subject teacher and the Department concerned, MSE and ESE shall be conducted centrally by the Examination Section of the College. The records of both CIE and ESE shall be maintained by the Examination Section.
7. The performance of students at every stage of the CIE shall be announced by the concerned subject teacher within a fortnight of the date of the particular assessment. The subject teacher shall also show the assessed answer books to the students before submission of the final marks to the Controller of Examinations.

8. The concerned subject teacher shall also be responsible to award letter grades to the students after the ESE is completed and to submit the final results of the course within one week of the last date of ESE to the Controller of Examinations through the Head of his/her Department.

(b) Question Papers: For being able to conduct achievement testing of the students in an effective manner, good question papers shall be used as the principal tool, making it necessary for the question papers at CIE and ESE to:

i. Cover all sections of the course syllabus uniformly;
ii. Be unambiguous and free from any defects/errors;
iii. Emphasize knowledge testing, problem solving & quantitative methods;
iv. Contain adequate data/ other information on the problems assigned;
v. Have clear and complete instructions to the candidates.

(c) Therefore, the question papers, particularly at ESE, shall be set covering the entire syllabus and the students given opportunity to answer questions from the full syllabus of the course by restricting their choice out of each unit in the syllabus. For this to be realized,

(d) Besides, the course syllabi shall be well drafted, be defect-free and properly unitized (or modularized) to enable the distribution of questions in the question papers to cover the whole syllabus. These aspects shall have to be taken into account, in particular, by the concerned DUPCs.

(e) There shall be two types of questions to be set by the subject teacher for the question papers at both CIE and ESE, viz.,

i. Multiple Choice Questions, having each question to be answered by tick marking the correct answer from the choices (commonly four) given against it. Such a question paper shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students. Usually, no more than 15- 20% of the questions in a paper for CIE or ESE shall be of this type.
ii. Comprehensive Questions, having all questions of the regular type to be answered in detail. Such a question paper shall be useful in the testing of overall achievement and maturity of the students in a subject, through long questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation.

(f) Examinations: The College shall maintain a high standard in both CIE and ESE and ensure the declaration of final results including SGPA and CGPA of the courses attended by a student in a semester before the end of the semester as per the Academic Calendar. For meeting these requirements, the College shall take the following steps:

i. CIE shall be conducted exclusively by the subject teacher, who shall spell out the components of CIE in advance, maintain transparency in its operation, declare the evaluation results in time and return the answer scripts and assignment sheets to the students on a regular basis after the evaluation is completed. The teacher shall also solve the questions asked in the tests at the tutorial sessions for the benefit of weak students.
ii. ESE shall be preferably conducted jointly by the subject teacher and an

external examiner appointed for this purpose by the College. In this case, considering the tight time schedule for the various tasks connected with ESE, the external examiner shall be associated with the teacher only in the setting of the question paper.

iii. The answer scripts of ESE shall be evaluated by the subject teacher only; but, an external review of the entire ESE shall be conducted under the aegis of the Board of Examiners of the College before declaring the results. This step shall be useful to the College to gain the confidence of the University on the fairness and transparency in the system.

iv. Suggested passing standard for each of the courses shall be 50marks from the CIE and ESE taken together.

v. Attendance at all examinations, both CIE and ESE of each course shall be compulsory for the students. Students having the following deficiencies shall not be permitted to attend the ESE:

A. Disciplinary action by the College pending against him/her;
B. Irregular in attendance at lecture/laboratory and other classes;
C. Failure to meet the standards of attendance prescribed;
D. CIE Performance far below the passing standard

(g) In the event of a final year student failing in a Laboratory course or scoring very low marks in the CIE of a subject or falling seriously ill during ESE, the subject teacher concerned shall have the discretion to grant the student extra time, not exceeding 12 weeks for satisfactorily completing the concerned course after awarding an I grade. If no such extra time is sought/granted, the concerned student shall have to re-register for the same in a succeeding semester and take steps to fulfill the requirements for the Degree award. The I grade shall be required to be converted into a regular grade within stipulated period indicated in the academic calendar.

(h) Re-Examination: There shall be no re-examination for any course at the College to take care of the failed students. Hence, the failed students shall re-register for the course (the same course, if it is hard core, or an alternative course, if it is a soft core or an elective) when it is offered again (either in a main or supplementary semester) and fulfill the passing standards laid down to earn the specified credits. However, there shall be make- up examination for a course to take care of students with the I or X grades in ESE.

(i) Make Up Examination: This facility shall be available to students who may have missed to attend the ESE of one or more courses in a semester for valid reasons and given the I grade; also, students having the X grade shall also be eligible to take advantage of this facility. The make up examination shall be held as per dates notified in the Academic Calendar. However, it shall be possible to hold a make up examination at any other time in the semester with the permission of the Dean, Academic Affairs. The standard of conducting this examination shall be the same as the normal ESE.

(j) Evaluation of Project work The project work shall be normally conducted in two stages, spread over one or two sequential semesters.

i. At the end of first stage, the student shall be required to submit for evaluation, a preliminary report of the work done before a prescribed date to the Project Coordinator, DUPC and present the same before an Internal Project Evaluation Committee. This shall be followed by taking up the second stage of work either in the same or the following semester.

ii. The Controller of Examinations shall receive a panel of names from the Chairman, DUPC for identifying the project examiners for the student, at least two weeks before the submission of the second stage of project work. This shall comprise of three unbound, typed copies of the project report (one for each examiner), prepared according to the prescribed format to be submitted to the Department at least one week before the date of oral examination.

iii. The Department shall record the date of submission of the project report and arrange to send copies of the same to the examiners a few days before the date fixed for the oral examination. The project coordinator shall notify the date of the oral examination to the examiners and also the student, with a copy marked to the Controller of Examinations. Then the project report shall be evaluated by the Project Evaluation Committee and the result submitted to the Project Coordinator, who in turn shall forward it to the Controller of Examinations.

iv. On successful completion of the oral examination, the student shall be required to submit two bound copies of the final, corrected project report, one being for the Department and the other for the project supervisor(s).

v. A student desirous of extension of time, up to a maximum of 3 months from the prescribed date for submission of the project report, shall seek permission for the same from the Project supervisor(s) and Head of the Department. The DUPC shall consider such requests, case by case, before giving the permission.

vi. If the DUPC is convinced that the progress of a student in project work is insufficient, the concerned students shall be temporarily awarded the I grade. Further, if the project report of the student is not submitted within the extended time period, the I grade shall be automatically converted to the FF grade.

vii. Such of the students who fail in the first stage assessment of project work shall be required to re-register for the first stage in the following semester. Likewise, those who obtain the FF grade in the second stage assessment shall be required to re-register for the same in the subsequent semester(s).

(k) The evaluation of performance in EAAc shall be done by the concerned faculty members, who shall communicate the student's performance to the Examination Section, soon thereafter.

**17. Grading System**:

(a) The College shall follow the award of letter grades and the corresponding grade points to the students based on their performance at the end of every semester, as given in Table 2, In addition to the grades given in the Table 2, the instructors shall use two transitional grades I and X as described in Clause (3) in this Section.

**Table 2: Letter Grades and Grade Points**

| Grade | Grade Points |
|---|---|
| AA | 10 |
| AB | 9 |
| BB | 8 |
| BC | 7 |
| CC | 6 |
| CD | 5 |
| DD | 4 |
| FF | 0 |
| PP (Only for Compulsory Non Credit Subjects) | 0 |
| AU (Audit Subject) | 0 |
| NP (Only for Non Credit Subjects) | Not Passed |

(b) A student is considered to have completed a course successfully and earned the credits if he/she secures a letter grade other than I, 'X' or FF in that course. Letter grade FF in any course implies failure in that course.

(c) The Transitional Grades I and 'X' shall be awarded by the teachers in the following cases:

i. Grade I to a student only on satisfactory attendance at classes and performance in other components of assessment, but absence from ESE in a semester for valid and convincing reasons acceptable to the Department, such as,

A. Illness or accident, which disabled him/her from appearing at the examination;

B. A calamity in the family at the time of the examination, which required the student to be away from the College;

ii. Grades X to a student on his/her overall performance in the course during the semester, highly satisfactory, i.e., high CIE rating, but a very low ESE performance resulting in an overall F Grade in the course.

iii. All the I and X grades awarded to the students shall be converted by the teachers to appropriate letter grades and communicated to the Academic Section (through Head of the Department) within two days of the respective make-up ESEs. Any outstanding I and X grades two days after the last scheduled make-up ESEs shall be automatically converted to FF grade.

(d) A *Semester Grade Point Average* (SGPA) shall be computed for all the students in a Department for each semester, as follows:

$SGPA = (C_1 * G_1 + C_2 * G_2 + C_3 * G_3 + \ldots + C_n * G_n) / (C_1 + C_2 + C_3 + \ldots + C_n)$

where, n is the number of courses registered during the semester, $C_i$ is the number of credits allotted to a particular course, and $G_i$ is the grade points corresponding to the grade awarded for the course.

(e) A *Cumulative Grade Point Average* (CGPA) shall be computed for all the students in a Department at the end of each semester by taking into consideration their performance in the present and the past semesters as follows:

$CGPA = (C_1 * G_1 + C_2 * G_2 + C_3 * G_3 + \ldots + C_m * G_m) / (C_1 + C_2 + C_3 + \ldots + C_m)$

where, m is the number of courses registered upto that semester, $C_i$ is the number of credits allotted to a particular course, and $G_i$ is the grade points corresponding to the grade awarded for the course.

(f )Whenever, a student repeats or substitutes a course in any semester, the lower of the two grades obtained by him/her in the course shall be ignored in the computation of CGPA from that semester onwards and the students shall be given the benefit of a higher grade.

(g) Both the SGPA and CGPA shall be rounded off to the second place of decimal and recorded as such for ease of presentation. Whenever the CGPAs are to be used for the purpose of determining the merit ranking in a group of students, only the rounded off values shall be made use of.

(h) When a student gets the grade I or X for any course during a semester, the SGPA for that semester and the CGPA at the end of that semester shall be tentatively calculated ignoring the I and X graded course(s). The SGPA and CGPA for that semester shall be finally recalculated after conversion of I and X grade(s) to appropriate grade(s), taking into account the converted grade(s).

(i)Other academic requirements for the Programme include the following two certifications as indicated earlier in clause (5) of Section 10, viz., PP (Passed) and NP (Not Passed) for EAA. However, there shall be no grade points are associated with these certifications and they do not figure in the calculation of SGPA or CGPA. But, obtaining a PP shall be a mandatory requirement to qualify for, the Degree award.

(j) It shall be open to each student to take additional courses for audit from the fifth semester onwards, with the concurrence of the Faculty Advisor. Students having CGPA ¿= 8.0 shall be normally encouraged to take such courses. While the performance of the student in audited courses shall be included in the Grade Card, they do not contribute to SGPA or CGPA of the concerned student.

## 18. Method of Awarding Letter Grades:

(a) The subject teacher(s) shall award the letter grade(s) to students based on the marks secured by them in both CIE and ESE together in the course(s) registered. This shall be done by following a relative grading system based on the use of statistics, for which the IUPC shall make available an appropriate software package.

(b) The subject teacher(s) shall submit two copies of the result sheet for each course, giving both the marks and the grades awarded to the Head of the Department, before the due date specified in the Academic Calendar. This shall be forwarded to the Controller of Examinations soon thereafter by the Head of the Department, after preliminary scrutiny and moderation (if necessary) at the DUPC level.

(c) All the evaluated answer scripts of CIE in a subject shall be returned to the students from time to time during the semester. However, the answer scripts of ESE shall only be shown to the students during the specified period after the evaluation and the detailed marks sheets together with ESE answer scripts and any other relevant papers connected with ESE shall be submitted by the subject teacher(s) to the Controller of Examinations who shall hold it for a period of at least one semester. Steps shall be taken to destroy the same only after obtaining permission from the Dean of Academic Affairs at the end of the prescribed period.

(d) Appeal: A student shall have the possibility to appeal to the Director against a subject teacher for awarding lower grade in a course than that expected by him/her, on payment of prescribed fees, before the commencement of the next semester. In such a case, the DUPC shall arrange a meeting of the aggrieved student together with a Committee comprising of the subject teacher, another subject expert from the College and the Head of the Department, who shall reconsider the evaluation done, show the answer script to the student. If the student is satisfied, the matter shall be closed at this stage. On the other hand, if a revision of marks allotted is called for, the same shall be carried out and all the records, including the Grade Card, corrected soon thereafter. In the latter case, the prescribed fee paid by the student shall be returned.

(e) Withholding of Grades: The Grades of a student in a semester shall be withheld and not declared if the student fails to pay the dues to the College or has disciplinary action pending against him/her.

19. **Eligibility for the Award of Degree**:

(a) A student shall be eligible for the award of B. Tech. Degree from the College and the University provided, he/she has:

(b) The Senate shall be the Recommending Authority for the award of B. Tech. Degree to students fulfilling the requirements specified under Clause (1) above and the Board shall be the Approving Authority.

(c) The Degree award shall then be granted by the University.

i. Completed all the prescribed credit requirements for the award of Degree with grade DD or higher, in each of the courses, like Theory, Laboratory, Studio, Workshop, Seminar and Project Work;
ii. Satisfactorily completed all the non-credit requirements with PP certification, covering EAA and Industrial Training, Field work, (if any);
iii. Obtained a CGPA of >= 5.00 at the end of the semester in which he/she completes all the requirements for the award of Degree;

iv. Paid all the dues to the College including the Department, Hostels, Library and other units; and,
v. No case or disciplinary action pending against him/her.

## 20. Eligibility for the CGPA improvement after completion of pre-requisite credits for the award of Degree:

Students who secure CGPA between 5 and 6.75 after completing the pre-requisite credits for the award of degree, and wish to improve their CGPA are permitted for CGPA improvement. Such students be permitted to withdraw their grade in a given course with poor grade and permitted to reappear for the examinations for improving the grade and in turn CGPA.

a) Student can appear for grade improvement examination within one year from the date of passing his/her PG or UG Examination. He should not have taken (i) Leaving Certificate from the Institute and ii) Degree from University of Pune through convocation. He/she will submit a written application to dean academics seeking his/her permission to register for class improvement within one month from the date of declaration of result or one week before the date of convocation of University of Pune whichever is earlier. This application will be forwarded to dean academics through the Head of the Department from where he/she has graduated. No student will be admitted once the subject registration process of that semester ends.
b) For grade improvement student will have to take maximum 3 subjects in which he/she has secured DD or CD grades from the same semester in one stretch.
c) Student can choose maximum three theory courses from a particular semester offered for T.Y and B. Tech (either odd or even) in which he/she has secured DD or CD grade. Student will have to register for these courses in a particular semester in which those subjects are offered.
d) At the time of registration student will surrender all the original mark lists given to him by the institute He will have to give an affidavit on 100 Rs. judicial stamp paper that he/she will not do any use of surrendered mark lists till he/she gets official result of the subjects for which he/she wishes to appear for grade improvement. No change of subjects or drop of subjects will be allowed after registration.
e) Student wishing to improve his/her grade will have to pay appropriate fees as laid down by the institute time to time.
f) Student wishing to appear for grade improvement is exempted from attending regular classes as he/she has already undergone the course instructions but he/she will have to appear for all the evaluation tests conducted for the particular subjects. No re-exam or retest will be allowed for the class improvement, in case of such students misses any of the tests or examinations. Absentee for End-semester examination will automatically lead to award of FF grade in that subject.
g) The grading process as used for the regular students appearing for that subject will be applicable and no concession of any sort will be granted on account of absentee for any of the examinations.
h) Student wishing to use the facility of grade improvement will have to pass in all the three subjects at a time for which he/she has registered for. He/she will not

be entitled for the summer term or re-examination in such cases.

i) Only one attempt will be permissible for any candidate wishing to use the facility of grade improvement. If the student fails to secure higher grades resulting in reduction in overall CGPA then the original resul t of the student before registering for grade improvement will be retained.

j) Student who improves his/her CGPA will be issued fresh mark lists by the institute. These mark lists will have star against the subjects for which he/she has appeared for grade improvement and will state *"Grade Improvement".* The date on the new mark lists will be that as issued for other students appearing in those subjects. Name of the student will be communicated to Pune University and he/she will have to apply for degree certificate from University of Pune thereafter.

## 21. Honors and Minor Certification Schemes at the Institute (To be implemented w.e.f A.Y. 2017-18 for Third Year Students:

- Aspiring student has to register for additional FOUR THEORY courses and acquire a additional (minimum) 12 credits (3 credits/course) for any ONE of BOTH the Schemes.
- Honors Certificate for Vertical in his/her OWN Branch for Research orientation; Minor in any OTHER Branch for Improving Employability.

- **For MINOR scheme:**
  - Every Department to develop and submit 'Minor-Courses-List' of 5-6 Theory courses with Titles and detailed syllabi, separately.
    - e.g. E & TC dept.: Linear & Digital ICs, DSP, Embedded Processors, Digital Communication, Communication Networks.
  - Student from ANY department is ELIGIBLE to apply for Minor from ANY OTHER DEPARTMENT.
  - The Scheme would start from 5$^{th}$ Semester of UG program and applicant must have a minimum CGPA of 6.0 (up to 4$^{th}$ Sem).
  - Host Department to float a SINGLE course from Minor-List, ONE in EVERY Semester starting from 5$^{th}$ Semester (Four courses in Four Semesters viz. 5, 6, 7, 8).
  - NO Lab course/Internship/Mini-project/MOOC permitted in Minor Scheme.
  - All Minor Courses to be designed and delivered by Departments only.

- **For HONORS Scheme:**
  - Every Department to develop and submit a 'Honors-Courses-List' of 5-6 Theory courses with Titles and detailed syllabi. MOOCs are permitted to be part of the list, so also a few PG courses. Multiple Verticals are encouraged. (e.g. Digital Communication/Signal Processing/Communication Networks/VLSI Design/Embedded Systems/ etc.)
  - Student from Host Department to undertake the Honors scheme for his/her own branch.
  - Scheme would begin from 5$^{th}$ Semester of UG program.

- Applicant should have CGPA score of 6.0 (up to 4th Semester)
- Host Department to float the courses from Honors-List as ONE in each Semester (viz. 5th, 6th, 7th, 8th Sem, of which preferably the SECOND course could be a MOOC from NPTEL/edX/Coursera/Udacity//PurdueNext/Khan Academy/QEEE etc. with examination given by the Department.

- **Implementation:**
  - 01 Minor & 01 Honors each = 02 Courses in every Semester beginning from 5th Sem. upto 8th Sem. Total: 08 Courses.
  - A Student opting for 'Honors' will NOT be ENTITLED to register for 'Minor'.
  - Allotment of SLOT in Time table on the line of ILOE (e.g. Mon-Wed: 9 to 10 am).
  - Department to identify and appoint a faculty member as 'Honors/Minor Coordinator' for guiding the aspirants.

- **Specific Remarks:**
  - Normal UG program for B.Tech. degree is therefore of **reduced credits in comparison to previous iterations of Curriculum revision, (170 credits across Eight semesters).**
  - Mediocre learner would find it bit easier to complete the program with good scores, with such reduced credits.
  - So, for Brighter Students opting Honors/Minor scheme, the UG program would be of **170 + 12 = 182 credits**.
  - Average learners can receive B.Tech degree with normal 170 credits.
  - The remedial assessment schemes such as Re-examination or Summer term will NOT be applicable for Minor or Honors schemes. Student failing in any of the Minor or Honors courses, at any stage will be discontinued from the Scheme.
  - The schemes shall also be open for Second Year Direct Admitted Diploma Students, with CGPA of Second Year at COEP exceeding 6.0.

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## Program Educational Objectives:

1. To produce around 75 electrical graduates annually who, immediately following graduation, are employable in the diversified sectors of the industry, government organizations, public sector and multinational corporations and/or pursue higher Educational in electrical or other fields of their interests, at institutes of repute and high standard.
2. To prepare graduates who demonstrate measurable progress in the fields they choose to pursue.
3. To prepare graduates, who are able to communicate effectively, adopt lifelong learning, act with integrity and have inter-personal skills needed to engage in, lead and nurture diverse teams, with commitment to their ethical and social responsibilities.

## Program Outcomes:

a. Knowledge of science, mathematics, and engineering principles.
b. Ability to apply this knowledge of science, mathematics, and engineering principles for solving problems.
c. Ability to identify, formulate and solve electrical engineering problems in the broad areas like electrical machines, analog and digital electronics, power systems and control systems.
d. Ability to understand and use different software tools in the domain of circuit, field, power system, control system simulations.
e. Ability to design and conduct experiments and analyze and interpret data.
f. Ability to function as a member of a multidisciplinary team.
g. Demonstrated sensitivity towards professional and ethical responsibility.
h. Ability to communicate effectively in writing as well as through public speaking.
i. Demonstrated ability to appreciate and engage in lifelong learning.
j. Demonstrated knowledge of contemporary issues.
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
l. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

## Program Objective and Program Outcome Mapping:

| PO→ PEO↓ | a | b | c | d | e | f | G | h | i | j | k | l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | √ | √ | √ | √ | √ | | | | | | √ | √ |
| 2 | | √ | √ | | √ | √ | √ | √ | √ | √ | √ | √ |
| 3 | | | | | | √ | √ | √ | √ | √ | | √ |

**Note:** The cells filled in with ✓ indicate the fulfillment/correlation of the concerned PEO with the PO.

## List of Abbreviations

| Abbreviation | Title |
|---|---|
| S.P. P.U. | Savitribai Phule Pune University |
| A.Y. | Academic Year |
| BSC | Basic Science Course |
| EFC | Engineering Foundation Course |
| MLC | Mandatory Learning Course |
| ILOE | Institute Level Open Elective Course |
| SLC | Self Learning Course |
| HSMC | Humanities/Social Sciences/Management Course |
| LLC | Liberal Learning Course |
| SBC | Skill Based Course |
| PCC | Program Core Course |
| DEC | Department Elective Course |
| LC | Laboratory Course |

**Semester III**

| Sr. No. | Course Type | Course Name | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1 | BSC | Ordinary Differential Equations and Multivariate Calculus | 2 | 1 | - | **3** |
| 2 | MLC | Professional Ethics and Value Education | 1 | - | - | **0** |
| 3 | HSMC | Innovation | 1 | - | - | **1** |
| 4 | SBC | Circuit Simulation Lab | - | - | 2 | **1** |
| 5 | PCC1 | Solid State Devices and Linear Circuits | 3 | 1 | - | **4** |
| 6 | PCC2 | Electrical Circuit Analysis | 3 | 1 | - | **4** |
| 7 | PCC3 | Electrical and Electronics Measurements | 3 | - | - | **3** |
| 8 | LC1 | Solid State Devices and Linear Circuit Lab | - | - | 2 | **1** |
| 9 | LC2 | Numerical Methods and Computer Programming Lab | 2 | - | 2 | **3** |
| 10 | LC3 | Measurement Lab. | - | - | 2 | **1** |
| | | | 15 | 3 | 8 | **21** |
| | | **Total Academic Engagement and Credits** | **26** | | | **21** |

**Semester IV**

| Sr. No. | Course Type | Course Name | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1 | BSC | Vector Calculus and Partial Differential Equations | 2 | 1 | - | **3** |
| 2 | BSC | Science of Living Systems | 3 | - | - | **3** |
| 3 | ILOE | Institute Level Open Elective [To be offered to other Departments] **Electrical Technology** | 3 | - | - | **3** |
| 4 | SBC | Data Structures and Computer Programming Lab | 1 | - | 2 | **2** |
| 5 | PCC1 | Electric Machinery I | 3 | 1 | - | **4** |
| 6 | PCC2 | Digital Electronics | 3 | - | - | **3** |
| 7 | PCC3 | Electromagnetic Fields | 3 | 1 | - | **3** |
| 8 | LC1 | Electrical Machinery I Lab | - | - | 2 | **1** |
| 9 | LC2 | Digital Electronics Lab | - | - | 2 | **1** |
| | | | **18** | **3** | **6** | **23** |
| | | **Total Academic Engagement and Credits** | **27** | | | **23** |

**Semester III (For Direct Second Year Admitted Diploma Students)**

| Sr. No. | Course Type | Course Name | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1 | BSC | Linear Algebra and Univariate Calculus | 4 | 1 | - | 5 |
| 2 | BSC | Foundation of Physics | 3 | - | - | 3 |
| 3 | MLC | Professional Ethics & Values | 1 | - | - | 1 |
| 4 | HSMC | Innovation | 1 | - | - | 1 |
| 5 | SBC | Circuit Simulation Lab | - | - | 2 | **1** |
| 6 | PCC1 | Solid State Devices and Linear Circuits | 3 | 1 | - | **4** |
| 7 | PCC2 | Electrical Circuit Analysis | 3 | 1 | - | **4** |
| 8 | PCC3 | Electrical and Electronics Measurements | 3 | - | - | **3** |
| 9 | LC1 | Solid State Devices and Linear Circuit Lab | - | - | 2 | **1** |
| 10 | LC2 | Numerical Methods and Computer Programming Lab | 2 | - | 2 | **3** |
| 11 | LC3 | Measurement Lab. | - | - | 2 | **1** |
| | | | **17** | **3** | **8** | **24** |
| | | **Total Academic Engagement Credits** | **32** | | | **28** |

**Semester IV**

| Sr. No. | Course Type | Course Name | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1 | BSC | Multivariate Calculus and Differential Equations | 4 | 1 | - | 5 |
| 2 | BSC | Science of Living Systems | 3 | - | - | 3 |
| 3 | ILOE | Institute Level Open Elective [To be offered to other Departments] **Electrical Technology** | 3 | - | - | **3** |
| 4 | SBC | Data Structures and Computer Programming Lab | 1 | - | 2 | **2** |
| 5 | PCC1 | Electric Machinery I | 3 | 1 | - | **4** |
| 6 | PCC2 | Digital Electronics | 3 | - | - | **3** |
| 7 | PCC3 | Electromagnetic Fields | 3 | 1 | - | **3** |
| 8 | LC1 | Electrical Machinery I Lab | - | - | 2 | **1** |
| 9 | LC2 | Digital Electronics Lab | - | - | 2 | **1** |
| | | | **20** | **3** | **6** | **25** |
| | | | | | | |
| | | **Total Academic Engagement and Credits** | **29** | | | **25** |

## Semester-III

### (MA 16001) Ordinary Differential Equations and Multivariate Calculus

**Teaching Scheme:**
Lectures : 2 Hrs/week
Tutorial: 1Hr/week

**Examination Scheme:**
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

**Course Outcomes:**

Students will be able to:

1. Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2. Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3. Analyze the problem and apply the appropriate concept. ( To measure this outcome, questions will be based on applications of core concepts)

**Unit I:**

Review of first order differential equations, Reduction of order, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients and reducible to differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters), systems of differential equations, applications to orthogonal trajectories, mass spring systems and electrical circuits. **[10 Hrs]**

**Unit II:**

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points, constrained optimization **[05 hrs]**

**Unit III:**

Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates, and substitutions in multiple integrals, Applications to Area, Volume, Moments and Center of Mass. **[11 Hrs]**

**Text Books**:

- Thomas' Calculus (12th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10th edition ) by Erwin Kreyszig, Wiley eastern Ltd.

**Reference Books**:

- K.D Joshi, "Calculus for Scientists and Engineers", CRC Press.
- Sudhir Ghorpade and Balmohan Limaye, "A Course in Multivariate Calculus and Analysis", Springer Science and Business Media.
- George Simmons, "Differential Equations with Applications and Historical notes", Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- C.R. Wylie, " Advanced Engineering Mathematics" , McGraw Hill Publications, New Delhi
- Peter V. O' Neil, "Advanced Engineering Mathematics", (7th edition) , Thomson.Brooks / Cole, Singapore.
- Michael D. Greenberg, "Advanced Engineering Mathematics", (2nd edition) by, Pearson Education.

## ( MA ) Linear Algebra and Univariate Calculus

(For Students Directly admitted to S.Y. after their Diploma)

**Teaching Scheme:**
Lectures : 4 Hrs/week
Tutorial: 1Hr/week

**Examination Scheme:**
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

**Course Outcomes:**

Students will be able to:

1. Know and recall core knowledge of the syllabus. ( To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2. Understand basic concepts. ( To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3. Analyze the problem and apply the appropriate concept. ( To measure this outcome, questions will be based on applications of core concepts)

4. Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
5. Apply core concepts to new situations. ( To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

**Unit I:** Matrices and linear equations: basic properties of matrices, row operations and Gauss elimination, Determinants and their basic properties. Basic concepts in linear algebra: vector spaces, subspaces, linear independence and dependence of vectors, bases, dimensions. Row and Column spaces, rank, Applications to systems of linear equations **[14 Hrs]**

**Unit II:** Linear mappings, representation by matrices, rank-nullity theorem, Eigen values, Eigen vectors and their basic properties, diagonalization. **[12 Hrs]**

**Unit III:** Review of limits, continuity and differentiability, Mean value theorems, Taylor's theorem, local extrema, increasing and decreasing functions, concavity, points of inflection. **[10 Hrs]**

**Unit IV:** Integrals as limits of Riemann sums, fundamental theorem of calculus, surface area, integrals by special techniques: reduction formulae, arc length, solids of revolution, improper integrals, tests for convergence, Gamma and Beta functions. **[12 Hrs]**

**Text Books**:

- Thomas' Calculus ($12^{th}$ edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics ($10^{th}$ edition ) by Erwin Kreyszig, Wiley eastern Ltd.

**Reference Books**:

- Serge Lang, "Introduction to Linear Algebra ($2^{nd}$ edition)", Springer.
- Howard Anton and Chris Rorres, " Elementary Linear Algebra ($10^{th}$ edition)", John Wiley and sons.
- K.D Joshi, "Calculus for Scientists and Engineers" , CRC Press.
- Sudhir Ghorpade and Balmohan Limaye, "A Course in Calculus and Real Analysis ($1^{st}$ edition)", Springer-Verlag, New York.
- C.R. Wylie, " Advanced Engineering Mathematics" , McGraw Hill Publications, New Delhi.

- Peter V. O' Neil, " Advanced Engineering Mathematics (7th edition)", Thomson.Brooks / Cole, Singapore.
- Shanti Narayan, " Differential Calculus", S. Chand and company, New Delhi.
- P.N. Wartikar and J.N. Wartikar, " Applied Mathematics Vol. I", (Reprint July 2014) , Pune Vidyarthi Griha Prakashan Pune.


## (HS 16001) Innovation

**Teaching Scheme:**
Lectures : 1 Hr/week

**Examination Scheme:**
"To be declared by the Instructor"

**Course Outcomes:**

At the end of the Course, Student will be able to:

1. Discover the creative / innovative side within her/him.
2. Hone entrepreneurial and leadership skills within his/her personality.
3. Develop new ways of thinking and Learn the entire innovation cycle from Ideation to Go-To-Market.
4. Study frameworks, strategies, techniques and business models for conceived ideas.
5. Develop skills for evaluating, articulating, refining, and pitching a new product or service.

**Syllabus:**

Introduction to Innovation, Personal thinking preferences, 'Innovation' mind set, Everyday creativity and eliminating mental blocks, Introduction to Innovation, Creative thinking techniques, Innovation types, Idea management and approaches, Teaming techniques for creativity, Idea Conception, Idea Scoping, Self Evaluation, Idea Brainstorming sessions, Idea Verification, Market Evaluation, Concept Evaluation, Idea Verification, Prototype Evaluation, Protection/Patent review, Innovation Case Study, Idea Presentations, Idea Incubation, Product and Market Plan, Product and Market Development, Innovation Case Studies, Idea Incubation and Product Launch, Marketing and selling, Post Launch Review

**Reference Books**:


- Jeff Dyer, Hal Gregersen, Clayton M. Christensen, " The Innovator's DNA: Mastering the Five Skills of Disruptive Innovators, Harvard Business Review Press, 2011.

- Paddy Miller, Thomas Wedell-Wedellsborg, "Innovation as Usual: How to Help Your People Bring Great Ideas to Life , Harvard Business Review Press, Kindle Edition.

## (EE 16003) CIRCUIT SIMULATION LABORATORY

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Practical: 2 hrs/week | Continuous evaluation: 50 Marks |
| | End Semester (Oral): 50 Marks |

**1 -2 assignments on following software will be conducted:-**

**1) Auto CAD Electrical.**

**2) MATLAB.**

**3) PSIM.**

**4) MSIM.**

## (EE 16004) Solid State Devices and Linear Circuits

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures : 3 hrs/week | T1 and T2: 20 Marks each |
| Tutorial : 1 hr/week | End-Sem Exam : 60 marks |

**Course Outcomes:**

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

1. Analyze simple lumped electric circuit models for resistors, sources, capacitors, diodes and transistors.
2. Apply operational amplifier models in circuits employing negative feedback.
3. Design electronics circuit using Timer IC and voltage regulators.
4. Perform analysis of amplifiers using small signal models for the circuit elements.
5. Calculate the frequency response of circuits containing BJT, Op-Amp etc.
6. Improve the logical thinking ability.

**Unit 1**

**Semiconductor Devices and their applications:**

Applications of diodes - clippers, clampers, multipliers, Types of diodes - Zener diode, Tunnel diode, schottky diode, LED, PIN diode, Photodiode etc, BJT- CB, CE, CC configurations, biasing, FET biasing, MOSFET biasing, NMOS, PMOS, CMOS, Device modeling. **[08 Hrs]**

**Unit 2**

**Signal and Power Amplifiers:**

Analysis of CB, CC, CE and FET amplifiers. Low and high frequency response of transistor and FET amplifier, Feedback in amplifiers, Oscillators. Transistor power amplifiers. **[08 Hrs]**

**Unit 3**

**Operational Amplifiers:**

The ideal Op-Amp, equivalent circuit of Op-Amp, ideal voltage transfer curve, open loop Op-Amp configurations, Op-Amp parameters, block diagram representation of feedback configurations, frequency response, high frequency Op-Amp. **[06 Hrs]**

**Unit 4**

**Active Filters and Oscillators:**

Active filters: low pass filter, high pass filter, band-pass filters, band reject filters, all pass filters, comparators and oscillators. **[06 Hrs]**

**Unit 5**

**Generalized Linear Applications:**

DC and AC amplifiers, instrumentation amplifier, logarithmic amplifier, voltage to current converter, current to voltage converter, the integrator, the differentiator. **[06 Hrs]**

**Unit 6**

**Specialized IC Applications:**

The 555 Timer as monostable, astable multivibrator, phase locked loops operating principles, 565 PLL applications, voltage regulators- fixed, adjustable, switching, special. Analog switch and analog multiplier. **[08 Hrs]**

**Text Books:**


- Millman, Halkias and Satyabrata Jit, " Electronic Devices and Circuits", 4th edition, McGraw Hill Education (India) Private Limited, 2015.
- Robert L. Boylestad and Louis Nashelsky, "Electronic devices and circuit theory", 11th edition, Prentice Hall India Ltd, 2015.
- Ramakant A. Gayakwad, "Op-Amps and linear integrated Circuits" 4th edition, Pearson Education, 2015.


**Reference Books:**


- A. S. Sedra and K.C.Smith, "Microelectronic Circuits", 6th edition, Oxford Publication, 2013.
- Thomas L. Floyed, "Electronic Devices", 9th edition, an Imprint of MacMillan publishing company,.
- James M. Fiore "Op Amps and Linear Integrated Circuits-Concepts and Applications", Cengage Learning.

- David A. Bell “Electronic Devices and Circuits”, 5th Edition, Oxford University Press

**e Learning Resources:**

- Prof. A. N. Chandorkar, IIT Bombay online lecture series on Analog Electronics http://nptel.ac.in/courses/117101106/
- Prof. S. Karmalkar, IIT Madras, online lecture series on Solid State Devices http://nptel.ac.in/courses/117106091/

## (EE 16005) ELECTRICAL CIRCUIT ANALYSIS

**Teaching Scheme:**
Lectures: 3 hrs/week
Tutorial : 1 hr/week

**Examination Scheme:**
T1 and T2-20 marks each
End-Sem Exam: 60 marks

**Course outcomes:**

At the end of this course students will demonstrate the ability to

1. Solve problems in Laplace Transform, Steady state and transient analysis of AC circuits
2. Analyze given waveform and extract various Fourier coeffients.
3. Solve two port network problems.

**Unit 1**

**Network theorems solutions of A.C. Network equations:**

A.C. circuit analysis: Thevenin theorem, Norton’s theorem, superposition theorem, maximum power transfer theorem, reciprocity Theorem,compensation theorem, application to AC circuits. Classical solution of first and second order differential equations for Series and parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants steady state and transient state response **[10 Hrs]**

**Unit 2**

**Sinusoidal steady state analysis:**

Representation of sine function as rotating phasor, stead state response using phasor, frequency response plot of electrical network (magnitude and phase plot) power transfer and insertion loss of two port network, effective or RMS values, average power and complex power. **[06 Hrs]**

**Unit 3**

**Electrical Circuit Analysis Using Laplace Transform:**

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for all standard input cases, convolution integral, inverse Laplace transform, transformed network with initial conditions. **[08 Hrs]**

**Unit 4**

**Two Port Network and Network Functions:**

Two Port Network and Network Functions:

Terminal pairs, relationship of two port variables, Z, Y, transmission parameters and hybrid parameters, interconnections of two port networks. Network Functions for one port and two port, calculations of network functions for ladder and general network, poles and zeros, restrictions on pole and zero locations for driving point and transfer functions, time domain behavior from pole and zero plot, stability of active network. **[08 Hrs]**

**Unit 5**

**Network Topology:**

Concept of graph, tree and co-tree, tie set and cut set matrices and Kirchhoff 's laws to network analysis, choice between loop and nodal analysis, concept of super loop and super mesh, dot convention for coupled circuits, concept of duality and dual networks. **[06 Hrs]**

**Unit 6**

**Fourier series and Signal Spectra:**

Fourier series, evaluations of Fourier coefficients, waveform symmetries as related to Fourier coefficients, convergence in truncated series, and exponential form of Fourier series.

**[06 Hrs]**

**Text Books:**


- M.E.Van Valkenburg, "Network Analysis", Prentice Hall, 3rd edition.
- D.Roy Choudhury,"Networks And Systems" New Age International Publications, 2nd edition


**Reference Books:**


- Alexander and Sadiku, "Electric Circuits", second edition, 2004.
- William H. Hayt, Jack E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill international,5th edition.
- K.V.V. Murthy and M.S.Kamath, "Basic Circuit Analysis", first edition (reprinted with corrections), Jaico Publishing.

## (EE 16006) ELECTRICAL AND ELECTRONICS MEASUREMENTS

**Teaching Scheme:**
Lectures : 3 hrs/week

**Examination Scheme:**
T1 and T2: 20 marks each
End-Sem Exam: 60 marks

**Course Outcome:**

At the end of this course students will demonstrate the ability to

1. Identify various basic movement systems, gain proficiency in the use of shunts and multipliers and calibration of energy meters and wattmeters.
2. Solve the problems for measurement of resistance, inductance and capacitance using various dc and ac bridges.
3. Analyze the functioning and use of electronic meters in electronic networks.
4. Identify and select different electronic and electrical transducers for measurement of various electrical and non electrical quantities.

**Unit1**

**Electrical measurement and Measuring Instrument:**

Definition of measurement, Unit, Dimensions, classification of instruments, PMMC, moving iron, dynamometer and induction type instruments, ammeter, voltmeter, wattmeter and energy meter, Measurement of power in balanced and unbalanced electrical systems.

**[07 Hrs]**

**Unit 2**

**Measurement of resistance, Inductance and capacitance:**

Measurement of low, medium and high resistance, insulation resistance, earth resistance, Wheatstone bridge, Kelvin double bridge, Megger, AC bridges for measurement of inductance and capacitance. **[06 hrs]**

**Unit 3**

**Instrument transformers and Special measuring instruments:**

Instrument transformers- current transformers, potential transformers, ratio and phase angle errors, design considerations and testing. Special measuring instruments: dynamometer type single and three-phase power factor meter, digital frequency meters, synchroscopes, tri-vector meter, Maximum demand meter, flux meter. **[07 hrs]**

**Unit 4**

**Electronic Measurements:**

Average, peak and true rms response instruments, Hall Effect instruments, digital voltmeter, multimeter, wattmeter and energy meter. Cathode ray oscilloscope: time, frequency and phase angle measurement using CRO, Digital Storage Oscilloscope, harmonic and distortion

analyzer, Spectrum and Wave analyzer, power analyzer. **[06 hrs]**

**Unit 5**

**Introduction to Instrumentation:**

Definition of instrumentation, purpose of instrumentation. Transducers: definition, classification, selection of transducers, resistive transducers. **[06 Hrs]**

**Unit 6**

**Measurements of Non-electrical quantities:**

Force measurement using strain gauges, displacement measurements using LVDT, temperature measurement using RTD, thermistor, thermocouple, bellows, and diaphragm. Flow measurement using rotameter, electromagnetic flow meter. Speed measurement using magnetic pick-up and photoelectric pick-up. **[06 Hrs]**

**Text Books:**


- A. K. Sawhney,"A course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Sons, 1995.
- Helfrick and Cooper, "Modern Electronic Instrumentation and Measurement Techniques" Pearson, 2007.
- M. U. Reissland, "Ellectrical Measurements", Wiely Eastern Ltd., New Delhi, 1992


**Reference Books:**


- M. A. Baldwin, "Fundamentals of Electrical Measurements, Publication - Lyall Book Depot, Ludhiyana.
- V. Popov, "Electrical Measurements, Publication - Mir, Moscow.
- Jones B.E.,"Instrumentation Measurement and Feedback", Publication-Tata McGraw Hill, New Delhi, Edition 1978.
- Enotes: *elearning.vtu.ac.in/, nptel.iitg.ernet.in/*


## (EE 16007) Solid State Devices and Linear Circuits Laboratory

**Teaching Scheme:**

Practical: 2 hrs/week

**Examination Scheme:**

Continuous evaluation: 50 marks

End-Sem Evaluation-: 50 marks

**Course Outcomes:**

At the end of this course students will demonstrate the ability to

1. Analyze and evaluate a wide variety of analog circuits.
2. Use books and periodicals to examine circuit ideas and to supplement textbook knowledge.
3. Build circuits and take measurements of circuit variables using tools such as oscilloscopes, multimeters, and signal generators.
4. Use software packages like Proteus, Multisim, PSpice etc.
5. Apply the knowledge for design and construction of circuits for projects.

**List of Experiments:**

The laboratory course have any 12 experiments from following list. At least 3 experiments should involve simulation using Proteus or appropriate software.

1. To design, assemble and test the wave shaping circuit using diode - clipping and clamping circuits.
2. To design, assemble and test the voltage multiplier circuits and to analyze its regulation and frequency characteristics.
3. To determine the performance characteristics of BJT using AC and DC biasing analysis of CE, CB and CC Configuration on hardware and on Proteus.
4. To determine the frequency Response of a BJT/FET single stage and multistage amplifier and to study the effect of coupling and bypass capacitor on the frequency on hardware and on Proteus..
5. To analyze Class A transformer coupled and Class B push-pull symmetry complementary amplifiers on hardware as well as on Proteus..
6. To obtain the drain and transfer characteristics of JFET.
7. To estimate common mode gain, differential gain, common mode rejection ratio of a CE differential amplifier on Multisim.
8. To design and test dependent voltage and current sources using an Op-Amp and to determine their frequency response.
9. Analysis and applications of active circuits using Op-Amp: (i) Comparator (ii) Zero Crossing Detector, (iii) Integrator, (iv) Logarithmic amplifier, (v) Differentiator.
10. To d design, assemble and test the active filters and oscillators using Op-Amp and determine their frequency stability: (i) Low pass, (ii) High pass, (iii) Band pass, (iv) Band reject, (v) All pass, (vi) Phase Shift oscillator, (vi) Wein Bridge Oscillator.
11. To design, assemble and test the Multivibrators using Op-Amp: (i) Schmitt Trigger (ii) Monostable Multivibrator (iii) Bistable Multivibrator (iv) Astable Multivibrator.

12. To operate Timer IC 555/556 as (i) Schmitt Trigger (ii) Monostable (iii) Astable (iv) Sequence Timer.
13. To design, assemble and test the voltage regulators using voltage regulator IC's 78xx and 79xx, LM 317 etc.
14. To determine the lock range, free running range and capture range of PLL.
15. To design and test the given electronic application using hardware and software.
16. To perform the analysis and fault diagnosis of given electronic circuit hardware and software.

## (EE 16008) NUMERICAL METHODS AND COMPUTER PROGRAMMING LAB

**Teaching Scheme:**
Lectures : 2 hrs/week
Practical: 2 hrs/week

**Examination Scheme:**
Continuous evaluation: 50 marks
End-Sem Evaluation-: 50 marks

**Course outcomes:**

At the end of this course students will demonstrate the ability to

1. Understand various aspects of MATAB and its utility as tool in coding various numerical methods.
2. Application of various numerical methods for analysis of Electrical Engineering problems.
3. Develop MATLAB programs for numerical methods.

**Unit 1**
**Introduction:**

Role of mathematical modeling in engineering problem solving, approximations and different types of errors, Taylor series, introduction to MATLAB programming. **[06 Hrs]**

**Unit 2**
**Roots of equations:**

Roots of algebraic and transcendental equations: Bracketing methods- bisection method, false position, Open methods - Newton Raphson, application: Analysis of electrical circuits using above methods. **[04 Hrs]**

**Unit 3**

**Linear Simultaneous algebraic equations:**

Cramer's rule, Gauss elimination - pitfalls and remedies, Gauss-Seidal, Gauss-Jordan method, Newton Raphson method. Introduction to eigen value and eigen vectors and iterative method to estimate them application: solving resistive networks. **[04 Hrs]**

**Unit 4**

**Curve fitting:**

Interpolation -Newton's polynomial, Lagrange polynomial **[02 Hrs]**

**Unit 5**

**Numerical Integration and Differentiation:**

Integration: Newton-Cotes formulae - Trapezoidal rule, Simpson's Rule. application: calculation of RMS values. **[04 Hrs]**

**Unit 6**

**Ordinary Differential equations:**

Euler's method, Modified Euler's method, Runge-kutta methods. **[04 Hrs]**

**Text Books:**


- Steven Chapra, Raymond P. Canale, "Numerical Methods for Engineers", McGrawHill International Student Edn
- Santosh K. Gupta, "Numerical Methods for Engineers", Wiley Eastern.
- S.S.Sastry, "Numerical Methods", Prentice Hall of India, New Delhi(3rd Edition)
- Rudra Pratap, "MATLAB Programming" Tata McGraw Hill, New Delhi.


**Term work:**

• It shall comprise of 12 programs in MATLAB for solving problems demonstrating use of various numerical methods learned in above 6 units.

**Objective:**

- To introduce basic numerical techniques and demonstrate their use in Electrical Engineering applications.
- To gain experience using MATLAB.

## (EE 16009) MEASUREMENT LABORATORY

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Continuous evaluation : 50 marks
Exam: 50 Marks

**Laboratory Outcomes:**

At the end of the laboratory work, students will demonstrate the ability to:

1. Explain and physically identify the parts like moving coil, control system, damping systems, pointer, shunts, multipliers etc. of different types of deflection systems.
2. Handle cathode ray oscilloscope independently and use it effectively for measurement of various patterns, waveforms.
3. Measure power in three phase circuits using analog wattmeters and also by using digital power analyzers.
4. Demonstrate working of Various Biomedical Instruments.
5. Recognize various transducers and use them in the measurement of various electrical and non-electrical quantities.

**List of Experiments:**

1. Study of Moving iron, PMMC and Dynamometer type instruments(Basic moving systems).
2. Measurement of power in three phase balanced and unbalanced circuits by conventional two wattmeter method and by power analyzer.
3. Comparative study of temperature measurement using RTD and thermocouple.
4. Study of strain gauge and measurement of force using it.
5. Measurement of Light intensity using Lux-meter and to realize the light intensity distribution with change in distance.
6. Study of construction of LVDT and measurement of displacement, force and pressure by using it.
7. Calibration of Single phase energy meter (Analog and Digital) for energy measurement.
8. Measurement of R, L and C Using Different Bridges and confirmation with analytical calculations.
9. Speed measurement using photoelectric pick up, magnetic pick up and stroboscope.
10. Demonstration of Biomedical Instruments: Electrocardiogram (ECG), Sphygmomanometer (Blood Pressure measurement).

## SEMESTER-IV

### (MA 16002) Vector Calculus and Partial Differential Equations

**Teaching Scheme:**
Lectures : 2 hrs/week
Tutorial: 1hr/week

**Examination Scheme:**
T1 and T2: 20 marks each
End-Sem Exam: 60 marks

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

1 Know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)
2 Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)
3 Analyze the problem and apply the appropriate concept. ( To measure this outcome, questions will be based on applications of core concepts)
4 Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.)
5 Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)
6 Organize and present thoughts. (To measure this outcome, questions may asked to write summaries and short notes on a given topic.)

**Unit I :**

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss, arc length parameterization, applications. **[09 Hrs]**

**Unit II:**

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, heat equation, potential equation, vibrations of circular membranes. [**10 Hrs]**

**Unit III:**

Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform. **[07 Hrs]**

**Text Books**:

- Thomas' Calculus (12th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
- Advanced Engineering Mathematics (10th edition ) by Erwin Kreyszig, Wiley eastern Ltd.

**Reference Books**:

- C.R. Wylie, "Advanced Engineering Mathematics" , McGraw Hill Publications, New Delhi.
- Wendell Fleming, "Functions of several variables" , Springer-Verlag, New York.
- Fritz John, "Partial Differential Equations", (4th edition) , Springer.
- Peter V. O' Neil, "Advanced Engineering Mathematics", (7th edition), Thomson.Brooks / Cole, Singapore.
- Michael D. Greenberg , "Advanced Engineering Mathematics", (2nd edition) , Pearson Education

## (AS 16001 ) Science of Living Systems

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures : 3 lectures/week | T1-**20** (Classroom activity), |
| | T2-**20** (Assignment/s) |
| | Semester End Examination-**60** |

**Objectives:** To make students conversant with basic Biology regarding the life processes. To impart knowledge about the common corridors of biology and engineering as biologically inspired technologies like designs in nature, bioenergetics, bioprocesses, biomaterials, biomechanics, bioimaging, bioinformatics, bioinstrumentation etc. To introduce recent trends in biology viz. genetic & tissue engineering, stem cell engineering, bio and nanotechnology etc. with the objective of appreciating engineering principles in biological systems.

**Unit 1: Understanding Basics (6L)**

1. Engineering perspectives of biological sciences: Where engineering meets biology and where biology meets engineering. Biology as an integrated Science; Case studies on integrating biology with engineering.

2. Biopolymers and macromolecules – Structure and Function: Organic and inorganic molecules; Unique Properties of Carbon; Carbohydrates, Amino Acids and proteins, Lipids, Nucleic Acids, Vitamins and Minerals; The Rise of Living Systems.
3. Levels of organization of life : Cell as basic unit of life, prokaryotic and eukaryotic cells, microbes, plant and animal cells; Cell organelles – structure and function; Levels of organization of life - tissues, organs, systems and organism.

**Unit 2: Biological Processes and Bioenergetics (6L)**

1. **Energy Dynamics in Biology –**
    a) Photosynthesis and energy assimilation: aerobic and anaerobic systems. Applications
    b) Respiration and Electron Transport Chain: Mitochondria and respiration, ATP generation.
2. **Bioenergetics:** Thermodynamic principles applied to biology, negative entropy changes in biological systems, Free Energy, Chemical Equilibrium;
3. **Optimization of biological functions**: Metabolic networks; anabolism and catabolism; flux analysis (MATLAB).

**Unit 3: Living Systems (6L)**

1. **Transport Phenomena in Biological Systems:** Membrane channels and ion channels; Fluid flow and mass transfer
    a. In plants: Xylem and Phloem

    b. In animals: Blood and Lymph

    c. Transport of molecules and gases (Oxygen and Carbon dioxide); Heat Transport - Body temperature regulation.

2. **Communication:** Cell junctions, Cell-cell communications – cell signaling, Hormones, Pheromones; Chemotaxis. Communication in living systems by photo, bio, chemotactic methods.
3. **Defense mechanisms in plants and animals:**
    a. In plants: Herbivory, secondary metabolites.

    b. In animals: Innate and Adaptive immune systems.

**Unit 4: Techniques and Devices (6L)**

1. **Genetic Code** - Expression and Transmission of Genetic Information, The concept of DNA cloning; Mechanisms of Enzyme Action.
2. **Techniques for optimization:**
   **a. At molecular level:** Genetic Code and protein synthesis, DNA replication, RDT, DNA hybridization, Colony Hybrids, PCR, DNA microarray,

   **b. At cell level:** Hybridoma technology,

   **c. At tissue level:** Plant Tissue Culture, Animal Tissue Culture and Microbial Culture techniques; Tissue Engineering.

3. **Instrumental Methods of analysis** – A case study of protein purification and characterization: Principles and types of microscopy and spectroscopy, Chromatography, electrophoresis, diffusion, centrifugation, light scattering.

**Unit 5: Discovery and Innovation (6L)**

1. **Current trends and advances** in cell and molecular biology
2. **Landmark Discoveries**: Landmark discoveries in the field of Molecular Biology, Cell Biology and Genetics.
3. **Nanobiotechnology:** Micro-/Nanotechnologies for Interfacing Live Cells; Nanotechnology in Medicine – Diagnostics and Therapy; Biosensors; Nanotechnology in Agriculture; Biomemetics.
4. **Biomemetics:** Nature inspired processes applicable to the field of Engineering.

**Unit 6: Branch-wise**
**Branch: Electronics and Telecommunication Engineering**
**Biosensors** – Introduction to Biosensors, transducers, amplifiers; **Bioimaging**-Introduction to medical imaging and different medical Imaging modalities; Review of Signals and system; Electro Physiological Signal Analysis. Bio-telemetry Communication in living systems by photo, bio, chemo, tactic methods; **Diagnostic Devices**- Radiography, X-ray Computed Tomography Nuclear Medical Imaging, Ultrasound Imaging, Magnetic Resonance Imaging. **Therapeutic Devices**-Cardiac Pacemakers, Cardiac defibrillators, Surgical Diathermy, Diagnostic application of LASERs, High frequency heat therapy, Hemodialysis, Ventilators, Anesthesia machines, Automatic Drug delivery Systems, Electro Surgical units and safety.

**Branch: Instrumentation and Control Engineering**
Basic concepts of **Medical Instrumentation**: Generalized medical Instrumentation System, Medical Measurement constraints, Classification of Biomedical Instruments, Generalized static and dynamic characteristics, Design criteria, Commercial Medical Instrumentation Development process, Regulation of Medical Devices. **Biomedical transducers:** optical, photo- electric,

electrochemical, electrical, mechanical, electromechanical and thermoelectric. **Specialty areas in Bioinstrumentation**—Confocal, Tunneling, Sequencing, FACS, PCR, MRI, CT,USG, Endoscopy, ECG; Introduction to biosensors and tissue engineering.

**Branch: Mechanical Engineering**

Biomechanics, Human body motion, Prosthetics; Introduction to Ergonomics; Elements of Anthropometry; Physiology, Anatomy; Mechanical Properties of Bone and Soft Tissues Rehabilitation engineering, Biomimetics; Bio Material Handling; Hand Tool Design; Human Information Processing; Applications of Principles of Biomechanics in two and three dimensional kinematics; Fundamentals of Fluid Mechanics; Introduction to bio sensors and tissue engineering.

**Branch: Metallurgy and Material Science**

**Classification of biomaterials** –Comparison of properties of some common biomaterials; Effects of physiological fluid on the properties of biomaterials; Biological responses (extra and intra vascular system) to Metallic, Ceramic and Polymeric implant materials; Introduction to bio sensors and tissue engineering. Metals & alloys, composites and their advantages used in bio-industries; Materials in bio-printing. **Tissue Engineering and cloning:** Engineering cells, tissues and organs; Stem cells and translational medicine; Introduction to Gene Therapy; Bioengineering at molecular, cell and systems level; 3D bio-printing; Engineering Materials for Biomedical Applications.

**Branch: Production Engineering and Industrial Management**

Bio chemical engineering; Fermentation Technology, Bioreactors; Bio process Engineering; Use of living organisms (mostly microbes) to produce useful products. Biomechanics and ergonomics–production innovations.

**Branch: Electrical Engineering**

Alternative energy sources; Electrical signaling in biological system; Bioluminescence, bioelectricity, ECG.

**Branch: Civil Engineering**

Environmental engineering, Understanding ancient engineering. Designs in Nature; Bio radars.

**Branch: Computer and Information Technology –**

**Principles of Bioinformatics, Computational Biology:** Role of Computational Biology in Bioengineering; Genomics, Proteomics, Bioinformatics. Computational solutions to Biological Problems, Virtual systems Artificial Intelligence in Biomedical Engineering: Basics of Artificial Neural Networks.

**References:**


1. Lodish H, Berk A, Zipursky SL, et al. (2000) Molecular Cell Biology. W. H. Freeman.
2. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). *Lehninger principles of biochemistry*. New York: Worth Publishers.
3. Lewin B. (2000) Genes VII. Oxford University Press..
4. Rao CNR, et.al. Chemistry of Nanomaterials: Synthesis, Properties and Applications.
5. Eggins BR. (1006) Biosensors: An Introduction. John Wiley & Sons Publishers.
6. Palsson B.O. and Bhatia S.N. (2009) Tissue Engineering. Pearson.


**(MA ) Multivariate Calculus and Differential Equations**

(For Students Directly admitted to S.Y. after their Diploma)

**Teaching Scheme:**
Lectures : 4 hrs/week
Tutorial: 1hr/week

**Examination Scheme:**
T1 and T2: 20 marks each
End-Sem Exam: 60 marks

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

1 Know and recall core knowledge of the syllabus. ( To measure this outcome, questions may be of the type- define, identify, state, match, list, name etc.)

2 Understand basic concepts. (To measure this outcome, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.)

3 Analyze the problem and apply the appropriate concept. ( To measure this outcome, questions will be based on applications of core concepts)

4 Give reasoning. (To measure this outcome, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, proving implications or corollaries of theorems, etc.)

5 Apply core concepts to new situations. (To measure this outcome, some questions will be based on self-study topics and also comprehension of unseen passages.)

**Unit I:**

Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points **[06 Hrs]**

**Unit II:**

Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates. **[11 Hrs]**

**Unit III:**

Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss **[10 Hrs]**

**Unit IV:**

Review of first order differential equations, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters **[09 Hrs]**

**Unit V:**

Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform. **[07 Hrs]**

**Unit VI:**

Partial differential equations with separation of variables, boundary value problems: vibrations of a string, one dimensional heat equation. **[07 Hrs]**

**Text Books**:


- Maurice D. Weir, Joel Hass, Frank R. Giordano, "Thomas' Calculus", ($12^{th}$ edition) , Pearson Education.
- Erwin Kreyszig, " Advanced Engineering Mathematics", ($10^{th}$ edition ) , Wiley eastern Ltd.


**Reference Books**:


- K.D Joshi, "Calculus for Scientists and Engineers", CRC Press.
- Sudhir Ghorpade and Balmohan Limaye, " A Course in Multivariate Calculus and Analysis" , Springer Science and Business Media.
- George Simmons, " Differential Equations with Applications and Historical notes" , Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Wendell Fleming, "Functions of several variables" , Springer-Verlag, New York.
- Fritz John, "Partial Differential Equations", ($4^{th}$ edition) , Springer.
- C.R. Wylie, "Advanced Engineering Mathematics", McGraw Hill Publications, New Delhi.

- Advanced Engineering Mathematics (7th edition), Peter V. O' Neil, Thomson Brooks / Cole, Singapore.
- Michael D. Greenberg, "Advanced Engineering Mathematics ",(2nd edition) , Pearson Education.


**(ILOE ) ELECTRICAL TECHNOLOGY**

**Teaching Scheme:**
Lectures: 3 hrs/week
Tutorial:0 hr/week

**Examination Scheme:**
T1 and T2: 20 marks each
End-Sem Exam: 60 marks

**Course Outcomes:**

At the end of this course students will demonstrate the ability to:

1. Learn different types of power converters; and fundamentals of dc and ac motors.
2. Evaluate different types of dc and ac drives.
3. Acquire the knowledge of different heating and welding techniques used in industries.
4. Acquire the knowledge of industrial electrical systems and understand power quality problems.

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**Unit 1**

**Power Converters:**

Fundamentals of ac-dc, dc-dc, dc-ac and ac-ac converters, their applications, selection and sizing. Introduction to various PWM strategies and control. **[07 Hrs]**

**Unit 2**

**Dc Motors and Drives:**

Dc motor: Introduction, different types of dc motors, torque production, motional E.M.F, steady-state characteristics and armature reaction. dc motor drives, starting and speed control thyristor dc drive, chopper-fed dc drive and dc servo drive. Introduction to BLDC. **[08 Hrs]**

**Unit 3**

**A.C. Motors and Drives:**

Induction motor: Introduction, Advantages, basic principle of operation, influence of rotor current on flux, stator-current speed characteristics, method of starting, torque speed curves, speed control, equivalent circuit and power balance.

Inverter–fed Induction motor drive: comparison with dc drive, torque-speed characteristics, V/f operation, limitation imposed by the Inverter and limitation imposed by the motor **[08Hrs]**

**Unit 4**

**Industrial Heating and Welding:**

Introduction, advantages of electric heating, direct resistance heating, heat treatment by induction heating, dielectric heating and arc furnaces. **[07 Hrs]**

**Unit 5**

**Industrial Electrical Systems:**

11 kV system, LT panel/cables, basic protection, diesel generators, UPS, lift, battery systems, earthing and lightning protection, energy efficiency measures. **[06 Hrs]**

**Unit 6**

**Power Quality and Energy Economics:**

Power quality: definitions, importance, various causes and standards.
Power factor improvement: Need and various methods.
Energy economics :Industrial tariff and energy conservation. **[06 Hrs]**

## Text Books


- Roger C. Dugan and Mark F. McGranaghan "Electrical Power Systems Quality", Second edition, Tata McGraw-Hill.
- S. C. Tripathy "Electrical Energy Utilization and Conservation", Tata McGraw-Hill.
- Mohan and Undeland "Power Electronics Converters, applications and design", third edition,Wiley India.
- E. Fitzgerald, Charles Kingsley and S.D.Umans "Electric machinery", fifth edition, Mc Graw-Hill Book Company.


**(EE 16010) ELECTRIC MACHINERY- I**

| **Teaching Scheme:** | **Examination Scheme:** |
|---|---|
| Lectures: 3 hrs/week | T1 and T2: 20 marks each |
| Tutorial:1 hr/week | End-Sem Exam: 60 marks |

**Course Outcomes:**

At the end of this course, the students should be able to,

5. Identify type of Transformer and DC machine.
6. Select a suitable transformer and DC machine as per application.
7. Evaluate the steady state parameters, basic operating characteristics and performance of transformers and DC Machine.
8. Analyze and apply the energy conversion principles to rotating machines.

**Unit 1**

**Single Phase Transformer:**

Transformer construction, Ideal and practical transformer, exact and approximate equivalent circuits, no load and on load operation, phasor diagrams, power and energy efficiency, voltage regulation, parallel operation, effect of load on power factor, Per Unit system, excitation phenomenon in transformers, switching transients, Auto transformers, Variable frequency transformer, voltage and current transformers, welding transformers, Pulse transformer and applications. **[07 Hrs]**

**Unit 2**

**Three Phase Transformers:**

Constructional features of three phase transformers, Cooling methodology, Standard and special transformer connections, Phase conversion, Parallel operation of three phase transformers, three winding transformers and its equivalent circuit, On load tap changing of transformers, Modern trends in transformers, Type and routine tests, Standards. **[06 Hrs]**

**Unit 3**

**Electromechanical Energy Conversion Principles:**

Energy in a magnetic systems, field energy and mechanical force, energy in singly and multiply excited magnetic systems, determination of magnetic force and torque from energy and co-energy, Forces and torques in magnetic field systems, dynamic equations of electromechanical systems and analytical techniques. **[07 Hrs]**

**Unit 4**

**DC Generators:**

Construction of armature and field systems, Working, types, emf equation, Armature windings, Characteristics and applications, Building of emf, Armature reaction - Demagnetizing and Cross magnetizing mmfs and their estimation; Remedies to overcome the armature reaction; Commutation process, Causes of bad commutation and remedies.

**[06 Hrs]**

**Unit 5**

**D.C. Motors:**

Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine tests**.**

**[06 Hrs]**

**Unit 6**

**Special Machines:**

Constructional details of reluctance machine, variable-reluctance machines, basic VRM analysis, practical VRM analysis, stepper motors and their analysis, Brushless DC motors.

**[06 Hrs]**

**Text Books:**

- D. P. Kothari and I. J. Nagrath, "Electric Machines", Tata Mc Graw Hill Publication, 4th Edition 2010, Reprint 2012.
- A. E. Fitzgerald, C. Kingsley, S. D. Umans, "Electrical Machinery", Tata Mc Graw Hill, 2002, (6th edition).

**Reference Books:**

- Nasser Syed, "Electrical Machines and Transformers", A New York, Macmillon 1984.
- Langsdorf A. S., "Principles of DC Machines", 6th Edition, Mac Graw Hill Book Company 1959.
- Bhag S. Guru and Huseyin R. Hiziroglu, "Electric Machinery and Transformers", Third Indian edition, Oxford University Press, Reprint 2014.
- E- resource: **nptel**.ac.in/**courses**/108105017; NPTEL: Electrical Engineering, Electrical Machines –I.

## (EE 16011) Digital Electronics

**Teaching Scheme:**
Lectures: 3 hrs/week

**Examination Scheme:**
T1 and T2: 20 marks each
End-Sem Exam: 60 marks

**Course outcomes**

At the end of this course students will demonstrate the ability to

1. Understand digital circuits and binary number system.
2. Design and implement various logics using digital circuits.
3. Understand the process of digitization.
4. Design Combinational and Sequential logic circuits.
5. Understand fundamentals of Micro Processors

**Unit I**

**Fundamentals of Digital Systems and logic families:**

Digital signals, digital circuits, NAND and NOR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital ICs, digital logic families-RTL, DCPL,I2L, DTL, HTL,TTL, Schottky TTL, ECL, MOS Logic, CMOS logic, interfacing CMOS and TTL, Tri-state logic . **[07 Hrs]**

**Unit 2**

**Combinational Digital Circuits:**

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization. **[07 Hrs]**

**Unit 3**

**Sequential circuits and systems:**

A 1-bit memory, the circuit properties of bistable latch, the clocked SR flip flop, J-K-T and D-types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters. **[07 Hrs]**

**Unit 4**

**A/D and D/A Converters:**

Digital to analog converters: weighted resistor/convertor, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs . **[08 Hrs]**

**Unit 5**

**Semiconductor memories and Programmable logic devices (PLD's):**

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM),

content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

**[07 Hrs]**

**Unit 6**

**Fundamentals of Microprocessor:**

Fundamentals of Microprocessor-An ideal microprocessor, Microprocessor architecture, concepts of control bus, address bus, data bus, ALU, registers, program counter, flags, interrupts, timing and control unit, addressing modes, I/O devices, instruction decoding, M/C cycle, instruction cycle tec., Microprocessor based system-basic operation. (Processor unspecific generalized approach). **[06 Hrs]**

**Text Books:**

- R.P.Jain, "Modern Digital Electronics", Tata McGraw Hill, Third Edition, 2003.
- M.Morris Mano, "Digital logic and Computer design", Pearson Prentice Hall, 2011.
- Anand Kumar, "Fundamentals of Digital Circuits", Prentice-Hall India, 2003
- Malvino A.P., "Digital Electronics Principles".

**Reference Books:**

- Herbert Taub- Donald Schilling, "Digital Integrated Electronics", Tata McGraw Hill,
- Jacob Millman and Arvin Grabel, "Microelectronics", McGraw Hill Book Company.
- Ronald J Tocci "Digital systems principles and applications" 11th edition.

## (EE 16012) ELECTROMAGNETIC FIELDS

**Teaching Scheme:**
Lectures: 3 hrs/week
Tutorial : 1 hr/week

**Examination Scheme:**
T1 and T2: 20 marks each
End-Sem Exam-: 60 marks

**Course outcomes**

At the end of this course students will demonstrate the ability to

1. Ability to solve problems of capacitance, force and energy in Electro static devices by using Gauss's theorem, principle of superposition and principle of virtual displacement.
2. Solve magnetic field problems of various configurations by using Biot-Savart's law, Ampere's law and by solving Laplace's and Poisson's equations by different techniques.

3. Apply Faradays law of electromagnetic induction (as a component of Maxwell's equations) to solve and analyze problems of Performance and behavior of electromechanical devices such as Motors, Generators and Transformers.
4. Apply Maxwell's field equations to analyze the losses and to improve the performance of electromechanical devices and develop space-related thinking ability.
5. Analyze and apply the process of energy conversion and energy transfer to solve problems related to electromechanical devices, thereby the ability to synthesize different facets of composite problems.

**Unit 1**

**Vector analysis:**

Vector algebra - addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate system. Vector calculus - differentiation, partial differentiation, integration, vector operator del : grad, div. curl; integral theorems of vectors, application of the operator del, types of vector fields, time variation of vectors. Conversion of a vector from one coordinate system to another**.**

**[06 Hrs]**

**Unit2**

**Electrostatics:**

Coulombs' law, the principle of superposition, electric force and the concept of electric field (=E) continuous space distribution of electric charges, the flux of E and Gauss' theorem, electric potential, calculation of E fields by Gauss' theorem and potentials, electric dipole, conductors and insulators in electrostatic field, polarization, generalization of Gauss' theorem, capacitance and examples of capacitors, boundary conditions, steady electric current and electric field -energy and mechanical forces in electrostatic fields; - electrostatic forces, energy of charged conductors, energy in electric field, forces and pressure on conductor and dielectrics, stability of electrostatic system, solving electrostatic field problem, electric current, current density and electric force, the conservation of charge and the equation of continuity, electromotive force and the potentials in the electric circuit Ohm's law and joule's law, circuit laws. **[06 Hrs]**

**Unit3**

**Magneto statics:**

Magnetic force between two small moving charges and the concept of magnetic field. Bio-Savart's law and its application to various configurations. Magnetic flux density vector B and Magnetic flux .The law of conversation of magnetic flux, Ampere's law, magnetic scalar potential, application to various configurations. Magnetic fields of currents in presence of magnetic materials— current loop in a magnetic field (torque and behavior), elementary

current loop and aggregates of current loops. Magnetization vector. Generalization of Ampere's law. Magnetic fields intensity and its interpretation. Boundary conditions, effect of applied magnetic field on materials substances, magnetic characteristics of ferromagnetic materials, B-H curve of iron and hysteresis loops, magnetic circuit, magnetic field problems.

**[08 Hrs]**

**Unit4**

**Quasi-Static Magnetism:**

Time varying fields and electromagnetic inductions -total force between small moving charges, physical meaning of the electromagnetic field, electromagnetic induction, Faradays laws of electromagnetic induction and its generalization, applications of electromagnetic induction. Inductance:-inductance in terms of induced EMFs, calculation of inductance, Self and Mutual inductance. Interpretation of laws of electromagnetic induction with various examples. Flux linkages and moving field. Forces and Energy in static and quasi-static magnetic fields, energy relations and energy of a magnetic field, potential energy and location of stored energy. Calculation of forces, charge in a magnetic field, and on a circuit, Ampere-Laplace s law. Motion of charged particles in magnetic and electrical fields, energy stored in the magnetic field, reciprocity property of mutual inductance, potential energy and stored energy, forces and energy in terms of magnetic field vectors, forces on magnetized iron surface, hysteresis loss in iron, inductance in terms of stored energy, internal energy, internal self- inductance, energy and forces in electromechanical systems. **[10 Hrs]**

**Unit5**

**Maxwell Equations:**

The equation of continuity and displacement current, Maxwell's equations in different forms and the constitutive relations consequence of Maxwell's equations, plane electromagnetic waves in free space, boundary conditions with generalizations. Magnetic vector potentials:- Vector potentials and its applications, inductance in terms of vector potentials, application of ,magnetic vector potentials to time- varying fields, retard potential**.** **[05 Hrs]**

**Unit6**

**Energy Transfer in E.M. Fields and Poynting vector:**

Flow of energy in electromagnetic oscillatory systems, flow of energy, Poynting vector and complex Poynting vector, comments and alternate energy transfer vectors. Magnetic diffusion and Eddy currents, alternating current distribution in a semi infinite conducting block skin effect and power loss calculation of magnetic diffusion as an electrical transient, diffusion time constant. **[05 Hrs]**

**Text Books:**

- Matthew N. O. Sadiku, "Elements of Electromagnetics", Oxford University publication, 6th Edition, 2014.
- A.Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2nd Edition, 2009.
- A.Pramanik,"Electromagnetism-Problems with solution", Prentice Hall of India, Pvt. Ltd., 2nd Edition, 2012.

**Reference Books:**

- G.W.Carter,"The electromagnetic field in its engineering aspects", Longmans, 1st Edition, 1954.
- W.J.Duffin,"Electricity and Magnetism", McGraw Hill Publication, 3rd Edition (Rev), 1980.
- W.J.Duffin,"Advanced Electricity and Magnetism", McGraw Inc. US, 1968.
- E.G.Cullwick,"The Fundamentals of Electromagnetism", Cambridge University Press, 3rd Edition, 1966.
- B.D.Popovic,"Introductory Engineering Electromagnetics", Addison-Wesely, Educational Publishers Inc, International Edition, 1971.
- Wiilaim Hayt, " Engineering Electromagnetics", Tata McGraw Hill Education Pvt. Ltd., 7th Edition, 2012.

**Enotes:**

- *nptel.ac.in/downloads/*

## (EE 16013) ELECTRIC MACHINERY - I LAB

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Continuous evaluation : 50 marks
End-sem Practical Exam: 50 Marks

**Laboratory Outcomes:**

At the end of laboratory course the students should be able to

1. Differentiate between various types of Transformers and DC machines to identify its exact type based on constructional observations.
2. Determine transformer parameters by performing O.C. and S.C. test
3. Practically estimate losses for Transformers and DC machines.

4. Obtain efficiency and voltage regulation of transformers by direct/indirect load test
5. Determine efficiency and control speed of DC motor.

**List of Practical:**

1. To perform Open circuit (OC) and short circuit (SC) test on single phase transformer to estimate its core loss, copper loss and equivalent circuit parameters.
2. Direct load test on single phase and three phase transformer to obtain its % efficiency and % voltage regulation at various loading conditions.
3. Parallel operation of two single-phase transformers to study their load sharing under various conditions.
4. Open delta (V-V) connection of identical two single-phase transformers to obtain three phase transformation.
5. Verification of Scott-connection of two single-phase transformers to obtain 2 phase to 3 phase transformation.
6. Verification and analysis of no load current waveform of single phase transformer.
7. Separation of transformer core loss into eddy current loss and hysteresis loss.
8. Determination of magnetization, external and internal characteristics of a DC shunt generator.
9. Determination of efficiency of a DC shunt or compound generator at various loading conditions.
10. Speed control of a separately DC Shunt motor by- (i) armature voltage control and (ii) Field current control method.
11. Direct load test on separately excited DC shunt motor to obtain it's on load Efficiency.
12. Estimation of efficiency of a D. C. shunt or compound machine by performing
13. Swinburne's test.

## (EE 16014) DIGITAL ELECTRONICS LABORATORY

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Continuous evaluation : 50 marks
End SemExam: 50 Marks

**Laboratory outcomes:**

At the end of laboratory course students will demonstrate the ability to
1. Ability to realize the combinational circuits.
2. Ability to build arithmetic circuits.
3. Ability to design combinational circuits using MUX/DEMUX.

4. Ability to design of decoder driver to drive 7 segment display.
5. Ability to design the sequential circuits and their conversion.
6. Ability to design various ADC/DAC.

**List of Practical:**

1. Verify the Truth tables of Logic Gates.
2. Verification of Boolean Laws and D Morgan's theorem.
3. Realization of Combinational Circuits (Decoders/Encoders/Code Converters).
4. Design of arithmetic circuits: Half adder, Full adder, Subtractor and BCD Adder/Subtractor
5. Design of Flip Flops: S-R, J-K, D type and master slave with truth tables
6. Realization of Flip Flops using Logic Gates
7. Design of Counters using IC's: Up down, Decade, Synchronous, Binary, BCD counter
8. Design of Counters using flip flops.
9. Design of Ring Counter, Johnson Counter etc.
10. Study of MUX and DEMUX and function realization using data selector IC's.

Group B: (Any two)

11. Study of D/A and A/D converters (Any one of each class): R-2R ladder, weighted register method. Successive Approximation, Voltage to frequency conversion.
12. Design of Combinational circuits using MUX / DEMUX.
13. Study of Memories
14. Design of Decoder driver to drive 7 segment LED display.
15. Introduction of several IC's for analog multiplex.
16. Interfacing of CMOS TTL logic families.

## (EE 16015) Data Structures and Computer Programming Laboratory

| **Teaching Scheme** | **Examination Scheme** |
|---|---|
| Lectures : 1hrs/week | Continuous evaluation : 50 marks |
| Practical: 2 hrs/week | End-sem Exam: 50 Marks |

**Laboratory outcomes**

At the end of laboratory course students will demonstrate the ability to

1. Evaluate the fundamental programming concepts.
2. Analyze real life problems using Computers.
3. Create different programs using high level programming languages.

**Unit 1**

**Objects and Classes:**

Specifying the class, C++ Objects as physical objects and data types, constructors, destructors, overloaded constructors, objects as function arguments, member functions, memory allocation objects.

**Inheritance:** Derived class and base class, derived class constructors, class hierarchies, public and private inheritance, levels of inheritance, multiple inheritance. **[4 hrs]**

**Unit 2**

**Pointers, Virtual Functions:**

Addresses and pointers, pointers and arrays, pointers and functions, pointers and strings, memory managements, pointers to objects, pointers to derived classes, pointers to pointers. Virtual Functions, friend functions, static functions, assignment and copy-initialization, this pointer. **[4 hrs]**

**Unit 3**

**Introduction to Data Structures:**

Overview, abstract data types, types of data structures, what is algorithm?, how to analyze an algorithm?, big- Oh notation.

**Stacks:** definition, push and pop operation, application of stack, recursion, program implementation.

**Queues:** definition, add and delete operations, circular queue, application of queue, program implementation. **[4 hrs]**

**Unit 4**

**Linked Lists:** Definition, insert and delete operations with different combinations, circular linked list, doubly linked list, traversing the doubly linked list, insert and delete operations on doubly linked list, applications, program implementation

**Trees:** Definition, terminology, graphical representation, binary trees, linked list representation of binary trees, insert and delete operations for binary tree, binary search tree: definition and basic operations, tree traversals: preorder, in order, post order, program implementation. **[4 hrs]**

**Unit 5**

**Introduction to Database Management System:**

**Introduction:** Basic concepts, Advantages of a DBMS over file-processing systems, Components and overall structure of DBMS, Data Modeling, entity, attributes, relationships, constraints, keys E-R diagrams, Components of E-R Model. Relational Model: Basic concepts, Relational Query

Language**.** **[4 hrs]**

**Unit 6**

**Introduction to SQL:**

Introduction to SQL, Characteristics and advantages of SQL, SQL Data Types and Literals, DDL, Tables: Creating, modifying, deleting, Views: Creating, dropping, Updation using Views, DML, SQL Operators, SQL DML queries, SELECT query and clauses, Set Operations, Predicates and Joins, Set membership, Tuple variables, set comparison, ordering of tuples, aggregate functions, nested queries, Database modification using SQL Insert, Update and Delete queries, Dynamic and Embedded SQL and concept of stored procedures, Query-by-example. **[4 hrs]**

**Text Books:**

- E. Balguruswamy, "Object Oriented Programming with C++", 6th edition, Tata McGraw Hill Publication, 2013.
- Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database system concepts", 6th Edition, McGraw Hill International Edition. (http://www.db-book.com or http://codex.cs.yale.edu/avi/db-book/db5/slide-dir/)
- Raghu Ramkrishnan, Johannes Gehrke, "Database Management Systems", 3rd edition, McGraw Hill International Editions, 2014 (http://pages.cs.wisc.edu/~dbbook/).

**Reference Books:**

- Bjarne Stroustrup,"The C++ Programming Language", 4th edition, Pearson Education, 2013
- A. Berman, "Data Structures via C++", Oxford Publication, 2012.
- Robert Lafore, "Object Oriented Programming in C++", 4th edition, Pearson Education, 2008.
- Aaron M, Tenenbaum, Yedidyah Langsam, M.J. Augenstein, "Data structures using C and C++", 2nd edition, Pearson Education, 2015.
- Ramez Elmasri and Shamkant B. Navathe, "Database Systems: Models, Languages, Design and Application Programming", 6th edition, Pearson Education; 2014.
- Jesse Dunietz, Geza Kovacs, John Marrero," Introduction to C++", (http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-096-introduction-to-c-january-iap-2011/index.htm)

**Term work:**

The term work should consist of any 12 experiments based on various concepts covered in the theory.

## (AS16002) Foundation of Physics

Teaching Scheme :
Lectures:3 hrs /week

Examination scheme:
Test 1 & 2: 20 marks each
End Sem exam: 60 Marks

**Course Outcomes:**

**At the end of the course student should be able to**

a) Develop the understanding of laws of thermodynamics and their application in various processes, optics and their applications.
b) Solve the basic problems in Classical Mechanics
c) Derive the Wave Mechanics of microscopic bodies.
d) Formulate and solve the engineering problems on Electromagnetism.

**Unit 1 Thermodynamics** **(6 hrs)**

i) Heat as a form of energy , mechanical equivalent of heat, thermodynamic systems,
ii) Zeroth law and concept of temperature, first law & its mathematical statement,
iii) Second law and concept of entropy, third law of thermodynamics,
v) Concept of free energy; Gibbs and Helmoltz free energy.

**Unit 2 Waves motion & Optics** **(6 hrs)**

i) Logitudinal and transeverse waves, Light as an EM wave and it's graphical representation,
ii) General equation of traveling wave,
iii) Superposition principle, formation of stationary waves (with derivation),
iv) Huygen's Principle, Young's double slit experiment,
v) Interference of light due to thin film of uniform thickness and conditions for darkness and brightness,
vi) Diffraction due to a single slit; conditions of maxima and minima.

**Unit 3 General Mechanics** **(6 hrs)**

i) Kinetic energy and potential energy,
ii) Work done (single particle system only); work energy theorem,
iii) Conservative and non conservative forces, concept of central force, properties of central force,
iv) Laws of planetary motion (with mathematical statement).

**Unit 4 Introduction to Quantum Mechanics** **(6 hrs)**

i) Drawbacks of classical mechanics, Plank's quantum hypothesis, Dual nature of matter,
ii) De Broglie's hypothesis, de Broglie's wavelength,
iii) Photoelectric effect, Davisson-Germer's experiment,
iv) Heisenberg's uncertainty principle

v) Illustrations of Heisenberg's uncertainty principle; electron diffraction at a single slit

**Unit 5 Electrostatics** **(6 hrs)**

i) Coulomb's law in integral form, the electric field intensity ,
ii) Continuous charge distribution (Line, Surface & Volume),
iii) Introduction to Gauss's law, integral form of Gauss's law,
iv) Applications of Gauss's Law to simple 2D-3D problems ,
v) Line integral of electric field, concept of electric potential (V),
vi) Potential (V) due to continuous charge distribution.

**Unit 6 Magnetostatics** **(6 hrs)**

i) Steady currents ( line current ,surface current,volume current) & current densities,
ii) Magnetic field due to steady currents (Biot-Savert's law) and it's applications,
iii) Line integral of B over a closed loop,
iv) Ampere's Law and its applications to simple problems,
v) Closed surface integral of B (Non-existence of magnetic monopole).

**References:**

Unit 1: H. C. Verma & Halliday-Resnick (Sixth edition), B. B. Laud
Unit 2: Halliday-Resnick (Sixth edition )
Optics by Brij Lal (S. Chand Publication)
Unit 3: Classical Mechanics by P. V. Panat,
H. C. Verma, Halliday –Resnick (Sixth edition)
Unit 4: Halliday-Resnick (Sixth edition)
Unit 5 & 6: Classical Electrodynamics by David Griffith (Pearson India limited)